Virtual Reality as a Tool to Facilitate Empathy: Embodied Simulations and Perspective Taking in the Body of Another

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Empathy, Embodiment, and Self-Other Perceptions in First-Person Point-of-View Virtual Environments
View project
Virtual Reality and Empathy: Embodied Simulations and Perspective Taking in the Body of Another

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Abstract

Research paradigms for stimulating empathic responses in virtual reality change perceived self-other overlap through illusions that cause users to experience their own body as a virtual avatar with a different type of body. Virtual Alterity paradigms involve sharing aspects of another real person's first-person experience in interactive virtual environments. In this thesis, I define empathy as an other-directed emotion motivating concern for another's welfare, and argue that virtual alterity systems are better designed to facilitate empathy when conceived in this way, as compared to avatar illusions in VR.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title Page</td>
<td>1</td>
</tr>
<tr>
<td>Abstract</td>
<td>2</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>3</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>5</td>
</tr>
<tr>
<td>Table of Contents</td>
<td>6</td>
</tr>
<tr>
<td>Introduction</td>
<td>7</td>
</tr>
<tr>
<td><strong>Chapter 1: Establishing a Framework for Empathy</strong></td>
<td>8-10</td>
</tr>
<tr>
<td>1.1 Introducing Virtual Reality and Empathy</td>
<td>8</td>
</tr>
<tr>
<td>1.2 Defining Empathy</td>
<td>8</td>
</tr>
<tr>
<td>1.3 History of the Concept of Empathy</td>
<td>9-10</td>
</tr>
<tr>
<td>1.4 Dimensions of Disagreement</td>
<td>10-12</td>
</tr>
<tr>
<td>1.5 Neurobiological and Bodily Empathic Processes</td>
<td>12-13</td>
</tr>
<tr>
<td>1.6 Emotional Responses in Empathy</td>
<td>13-15</td>
</tr>
<tr>
<td>1.7 Cognitive Empathy</td>
<td>16-19</td>
</tr>
<tr>
<td>1.8 Phenomenological Approaches to Empathy</td>
<td>19-20</td>
</tr>
<tr>
<td><strong>Chapter 2: Embodied Simulations in VR</strong></td>
<td>22</td>
</tr>
<tr>
<td>2.1 Introducing Embodied Simulations</td>
<td>22</td>
</tr>
<tr>
<td>2.2 Embodied Simulation Setups</td>
<td>23-25</td>
</tr>
<tr>
<td>2.3 How Embodied Simulations Facilitate Empathy</td>
<td>26-26</td>
</tr>
<tr>
<td>2.4 History of Laboratory Bodily Illusions</td>
<td>26-31</td>
</tr>
<tr>
<td>2.5 Bodily Illusions in VR</td>
<td>31-33</td>
</tr>
<tr>
<td>2.6 Body Ownership Illusions and Empathy</td>
<td>33-35</td>
</tr>
<tr>
<td>2.7 Avatar Embodiment and Empathy</td>
<td>35-37</td>
</tr>
<tr>
<td>2.8 Limitations of Avatar Embodiment Studies</td>
<td>37-39</td>
</tr>
<tr>
<td>2.9 What Makes Virtual Alterity Systems Different</td>
<td>39-42</td>
</tr>
<tr>
<td><strong>Chapter 3: Perspective Taking in Virtual Alterity Systems</strong></td>
<td>43</td>
</tr>
<tr>
<td>3.1 Introducing Virtual Alterity</td>
<td>43</td>
</tr>
<tr>
<td>3.2 How Virtual Alterity Systems Facilitate Empathy</td>
<td>43-33</td>
</tr>
<tr>
<td>3.3 Features of Virtual Alterity Systems</td>
<td>44-50</td>
</tr>
<tr>
<td>3.4 Research Findings</td>
<td>50-56</td>
</tr>
<tr>
<td>3.5 Limitations of Virtual Alterity Setups</td>
<td>57</td>
</tr>
<tr>
<td><strong>Conclusion</strong></td>
<td>58</td>
</tr>
<tr>
<td>References</td>
<td>59-69</td>
</tr>
</tbody>
</table>
# List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR</td>
<td>Virtual Reality</td>
</tr>
<tr>
<td>VE</td>
<td>Virtual Environment</td>
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<td>IVE</td>
<td>Immersive Virtual Environment</td>
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<tr>
<td>HMD</td>
<td>Head-Mounted Display</td>
</tr>
<tr>
<td>SOM</td>
<td>Self-Other Merging</td>
</tr>
<tr>
<td>PT</td>
<td>Perspective Taking</td>
</tr>
<tr>
<td>VPT</td>
<td>Visual Perspective Taking</td>
</tr>
<tr>
<td>SPT</td>
<td>Social Perspective Taking</td>
</tr>
<tr>
<td>OBT</td>
<td>Own Body Transformation</td>
</tr>
<tr>
<td>BOI</td>
<td>Body Ownership Illusion</td>
</tr>
<tr>
<td>FBOI</td>
<td>Full Body Ownership Illusion</td>
</tr>
<tr>
<td>OBE</td>
<td>Out-of-Body Experience</td>
</tr>
<tr>
<td>VT</td>
<td>Visuotactile</td>
</tr>
<tr>
<td>VM</td>
<td>Visuomotor</td>
</tr>
<tr>
<td>IOS</td>
<td>Inclusion of the Other in the Self</td>
</tr>
<tr>
<td>MBA</td>
<td>The Machine to Be Another</td>
</tr>
<tr>
<td>PWM</td>
<td>Paint With Me</td>
</tr>
<tr>
<td>SoA</td>
<td>Sense of Agency</td>
</tr>
<tr>
<td>SIA</td>
<td>Shared Agency Illusion</td>
</tr>
</tbody>
</table>
Introduction

This thesis aims to analyze the capacity for virtual reality (VR) technology to allow us to see ourselves and one another differently. The notion of how we come to know, understand, and appreciate other minds is central to empathy, and technology is reshaping these processes. This thesis combines an analysis of empathy as a theoretical construct with an analysis of cutting-edge research on virtual environments that serve as interventions to facilitate empathic processes and contribute to greater real-world positive interpersonal attitudes and interactions.

Called “embodied simulations,” virtual environments allow users to embody different bodies, moving and seeing as another. While most of these embodied simulations involve embodying an avatar in computer-generated worlds, The Machine to Be Another involves embodying another real person through live video streams presented in VR head-mounted displays. The Machine to Be Another motivates a new direction for VR and empathy research and design, which I term virtual alterity. Virtual alterity projects aim to direct attention towards our experience of others as distinct subjective agents while engaging in coordinated activities.

While designing technologies to train and promote empathy is a laudable goal, my goal is to explore the mechanisms of how these technologies effectively promote empathy, and how they could be more effective by conceiving empathy through the lens of phenomenology.

PURPOSE

This thesis investigates VR projects that facilitate empathy on two distinct levels: embodied simulation and perspective-taking. One limitation to these designs is that they do not involve interacting with another real person. I propose virtual alterity systems as an alternative paradigm to facilitate empathy by combining aspects of embodied simulations and perspective-taking VR with another real person. This alternative paradigm to facilitate empathy in VR is based on understanding empathy in a phenomenological, other-directed way.

STRUCTURE

In Chapter 1, I review the history, theory, and empirical research on empathy and provide dimensions of disagreement in the literature. I provide examples of VR projects that extend previous empirical findings. I present a phenomenological account of empathy that I then use to frame my research and design goals for virtual alterity systems.

In Chapter 2, I explain the laboratory research on bodily illusions that lay the groundwork for current designs of embodied simulations. These embodied simulations take two forms: avatar embodiment and virtual alterity. Chapter 2 focuses on avatar embodiment but presents virtual alterity as an alternative. In this chapter, I discuss limitations of avatar embodiment studies and outline ways in which virtual alterity projects offer a different instantiation of VR to facilitate empathy.

In Chapter 3, I present the key design features of virtual alterity in current instantiations as well as suggesting ways to combine features of perspective-taking VR with embodied simulation. In this chapter I also present research findings from two studies on The Machine to Be Another Body Swap and Paint With Me. Then I discuss limitations of virtual alterity projects in relation to the definition of empathy I provide in Chapter 1.

In the Conclusion, I review key findings and suggest directions for future research on VR and empathy.
**PROBLEM FORMULATION**

Dazzled by the capacity of Virtual Reality (VR) to allow users to feel a sense of presence in a different place than their physical body (Tamborini et al., 2004) and to elicit strong psychological effects and emotional reactions (Riva, et al., 2007), technology enthusiasts have hailed VR as the ultimate “empathy machine” (Milk, 2015). However, little research exists to justify this claim, nor to evidence VR as superior to other communication mediums for evoking empathy. While a Google search for “virtual reality and empathy” yields 490,000 results, an academic search with the same terms yields just 20 results on PubMed. This thesis was hugely served by research from two VR laboratories: Mel Slater’s Experimental Virtual Environments (EVENT) Lab for Neuroscience and Technology at the University of Barcelona, which studies the reduction of negative implicit biases through VR, and Jeremy Bailenson’s Virtual Human Interaction Lab (VHIL) at Stanford University, which in 2015 launched the “Empathy at Scale” project. This thesis serves as an early analysis of the potential for VR technology as a transdisciplinary research tool to study the psychological and phenomenological roots of empathy.

Current instantiations of VR towards empathy focus on surface-level, bodily cues that configure empathic possibilities based on automatic, rapid categorizations we make about others. While these projects provide a valuable foundation for the transformative effects of VR towards empathy, I suggest that these embodied simulations can be combined with perspective-taking interfaces to enhance our understanding of the subjective worlds of others. To the best of my knowledge, no one has yet done this.

This thesis serves as a proposal combining effects of VR research and design in a new initiative that I call virtual alterity. This proposal tackles empathy from several angles and explores the potential of VR to enhance empathic capacities and promote real-world empathic interactions.
Chapter 1: Establishing a Framework for Empathy

1.1 Introducing Virtual Reality and Empathy

Virtual Reality (VR) refers to computer-based simulations that substitute a user’s physical body movements and sensations in the real world with virtual stimuli that the user perceives as real. The hardware that creates VR includes head-mounted display (HMD) devices and multi-modal interfaces. VR allows users to experience a sense of "Presence" in an alternate reality, which is the illusion of being inside a computer simulation and with the ability to act in that world (Sanchez-Vives & Slater, 2005). In addition to being somewhere else (a virtual world), VR can also allow users to experience being someone else by “stepping into the shoes” of the first-person perspective of another real person or avatar.

Empathy is a multidimensional process activated in response to another person’s affective and cognitive state that involves an attempt to understand that person. Virtual Reality (VR) offers new media affordances such as presence, embodiment, and perspective-taking as tools to facilitate and cultivate these empathic processes. This chapter provides a framework for analyzing and interpreting empathy research and design protocols used in VR in the subsequent chapters. Based on this discussion, I present my own conceptualization of empathy, largely based in phenomenological literature. Empathy can be harnessed by the psychological effects of VR as an intervention to impact real-world prosocial attitudes, judgments, and behaviors. Ultimately, I argue that empathy is rooted in the experience of another as a subjective person. This is where current VR interventions for empathy fall short, and this thesis proposes virtual alterity systems as an alternative.

This first chapter on empathy will proceed with a review of the history of the concept of empathy. Then I outline dimensions of disagreement in current debates on empathy. Definitions of empathy are provided across four components: bodily, affective, cognitive, and phenomenological. Based on this discussion, I present my own conceptualization of empathy, largely based in phenomenological literature. This is central to framing the main conceptual basis and research aims of virtual alterity as an extension of existing VR interfaces designed to facilitate empathy.

1.2 Defining Empathy

Empathy is a polysemous and theoretically loaded term with a rich history in philosophy, anthropology, social psychology, psychotherapy, and more recently in cognitive and social neuroscience. Corona (2013) highlights a few agreed upon notions of empathy. The first is that empathy is an affective response to another person, which may involve sharing that person’s affective state (Decety & Jackson, 2006). The second theme in empathy literature is that there are two routes for activating empathy: direct perception of another’s state (bottom-up route), and a top-down reflective route involving cognitive abilities. The third theme is that the mature capacity for empathy involves the ability to recognize another person as distinct from oneself (the self-other distinction). The ability to differentiate and re-assimilate self and other is most central to the transformative effects of virtual alterity systems. The definition of empathy that I propose is based on phenomenological writings that specify empathy as taking another’s experience as the object of consciousness. This definition aligns with other-directed prosocial responses, making it a useful definition for measuring the outcomes of various VR interventions.
1.3 HISTORY OF THE CONCEPT OF EMPATHY

The English word “empathy” was coined in 1909 by the psychologist Edward Titchener as the translation of the German term “Einfühlung,” which was introduced by Robert Vischer (1873), and directly translates to “feeling into” the experience of another (as cited in Gallese, 2003). Titchener applied the word “empathy” in the context of aesthetics to explicate the process of imaginatively projecting oneself into an object or event as though to perceive it from the inside. Titchener (1909) defines empathy as “…a natural tendency to feel ourselves into what we perceive or imagine.” Titchener borrowed from Theodor Lipp’s (1905) writings on Einfühlung, describing empathy as a form of psychic participation with other beings and other objects by means of inner Nachahmung, or “inner imitation.” Titchener did not think that reasoning about another person’s mental state by analogy to one’s own mental processes was the correct mechanism for understanding another person’s conscious experience. Instead, he argued that other understanding occurs through a process of inner imitation and motor mimicry, which are precursors to the more contemporary neuroscientific research on simulation theory.

During the 1950s, clinicians and psychotherapists began to give empathy a more cognitive meaning, using it to refer to understanding a client’s point of view (Dymond, 1949). This cognitive definition of empathy is linked to the developmental processes of role-taking and perspective-taking as conceptualized by psychologists (Borke, 1971; Krebs & Russell, 1981; Underwood & Moore, 1982). In the 1960s, positive forms of social behavior were increasingly studied in social psychology, with helping, giving, and intervening as dependent variables (Wispé, 1981). This research was motivated by findings that sometimes people in groups do not act to help a person who is suffering, a phenomenon known as the bystander effect (Hoffman, 2008).

Through a series of experiments, Batson et al. (1981) demonstrated that empathy was a strong motivator for helping behavior. Empathy has been found to drive individuals both to learn from others’ experiences and to feel joy by helping someone in need (McCall & Singer, 2013). The “Empathy at Scale” project has demonstrated efficacy in using VR to increase greater real-world prosocial helping behavior after interventions that facilitate perspective-taking, locus of control (the sense that one’s own actions have an impact), and that allow a person to see themselves as heroic (Ahn, Le, & Bailenson, 2013; Rosenberg, Baughman, & Bailenson, 2013). Training interventions related to empathy can reduce aggressive behavior and bullying while improving emotional and social skills (Gordon & Green, 2008). VR simulations of bystander bullying have been effective in generating greater intention to intervene in future bystander situations (McEvoy, 2015). Empathy may increase intergroup fairness (Page & Nowak, 2002) and reduce intergroup bias. Intergroup bias is a form of “othering,” seeing the other as an alien or outsider and favoring in-group members with whom one is familiar and can identify, an “us versus them” mentality (Brewer, 1979). University of Barcelona’s EVENT Lab has effectively used embodied simulations in VR to reduce out-group biases (discussed in Chapter 2).

In psychological nomenclature, empathy occurs when an “empathizer” observes a “target” and the empathizer emotionally resonates with and cognitively understands the target’s first-person experience. For the purposes of this thesis, empathy can be divided into three key phases: response, motivation, and prosocial attitude/behavior. First, is some form of biological, bodily, emotional, and/or neurological response to another’s affective state. Then, this incites a motivation for involvement with the other. Finally, one exhibits various attitudes or behaviors aimed to benevolently participate in or intervene with the other’s affective state, such as alleviating suffering. Empathy has been identified as a motivational factor contributing to pro-sociality (see Batson, 1991), such as helping behavior (Wilhelm & Bekkers, 2010; Batson & Coke, 1981), concern for another’s welfare (Batson et al., 2007), intergroup fairness (Page & Nowak, 2002), sharing behavior (Staub, 1971), donations to charitable causes (Warren & Walker, 1991), and advocacy for marginalized populations (Rios, Trent, & Castañeda, 2003). Empathy is also linked to altruism, defined as working
towards a goal for the purpose of another’s welfare, and sometimes involving sacrificing one’s own well-being in service of another (see the empathy-altruism hypothesis, Batson et al., 1991).

The consensus definition of empathy in the literature is that it is an affective and cognitive process of tuning into another person’s psychological and emotional state, which may involve sharing, merging, concern, or interconnection, while recognizing the other person as distinct from oneself (Decety & Jackson, 2006). I argue that empathy does not only pertain to others who are in need of help, a heightened attunement towards another that strengthens interpersonal connections and our capacity to learn from one another. Empathy may help individuals understand others from different cultural backgrounds, value systems, intellectual or bodily capacities, and lifestyle practices. VR has a valuable role to play in the translation of experiential differences from one person to another because it can vividly, concretely, and directly represent what the mind would otherwise need to imagine. In this thesis, I postulate intersubjectivity, the sense of a shared experience, as a crucial component of empathy, amidst a heightened awareness of another person as a distinct subjectivity.

The notion of empathy as a trainable capacity is somewhat contentious (see Davis, 1996, for a review), and therefore a discussion of dimensions of disagreement in empathic literature is presented to carve out how and why measuring and training empathy can be so difficult.

1.4 DIMENSIONS OF DISAGREEMENT

Pagotto (2010) identifies three main dimensions along which various definitions of empathy differ: cognitive-affective, process-outcome, and dispositional-situational. The process-outcome dimension summarizes the tension between understanding empathy as a process that occurs when one is exposed to another’s affective state, or as the outcome of this process. The cognitive-affective dimension debates whether empathy is an emotional response to another, or a cognitive process of imagining another person’s point of view. The dispositional-situational dimension refers to whether empathy is a tendency within one’s personality (dispositional) versus a trainable capacity (situational). In this thesis, I will add an additional dimension, merging-distinction, which demarcates the primary difference between embodied simulations using avatars versus the perspective-taking virtual alterity projects with real people that this thesis proposes as an alternative model for facilitating empathy in VR.

1.4.1 PROCESS-OUTCOME

Process and outcome are often interdependent, as empathic processes usually contribute to greater empathic outcomes. Examples of empathic processes include taking the perspective of another person to better understand their experience, unconsciously imitating another’s facial expressions or gestures, vicariously ‘feeling’ another person’s physical and emotional states, and understanding the context of another’s thoughts and feelings within their life story. Examples of empathic outcomes involve greater interpersonal understanding, more benevolent attitudes towards others, increased support for social justice the target reforms, and increased helping behaviors. The process/outcome dimension is very important to isolate variables that arouse empathy (process) and to measure the efficacy of these variables (outcomes).

1.4.1.1 Automatic and Volitional Empathic Processes

Empathy involves both implicit, automatic processes, as well as more volitional and effortful processes. The automatic processes in empathy, white rooted in everyday experience, impact social perceptions of others that constrain more sophisticated empathic possibilities. Empathic processes such as spontaneous mimicry, imitation of facial expressions, and activation of shared neural and body representations are automatic and implicit. Research indicates that these automatic processes
are decreased with out-group members. VR interventions designed to facilitate automatic empathic processes aims to combat barriers to these automatic responses by increasing perceived self-other overlap and identification with out-group others. This is the goal of embodied simulation research using avatars, discussed in Chapter 2. Empathic processes such as perspective taking, mental or emotional state attributions, and narrative engagement are more effortful and volitional. Training designed to facilitate volitional empathic processes aims to amplify attention to and regard for others, such as by providing feedback on attribution accuracy and creating new modes of presentation for social cues and subjective-state information. This is the goal of perspective-taking virtual environments. Ultimately, this thesis argues that both automatic and volitional processes are important for empathy, and virtual alterity systems target both automatic and volitional empathic processes.

1.4.2 COGNITIVE-AFFECTIVE

Some researchers understand empathy as emotionally resonating with another person, while other researchers define empathy as cognitively understanding other’s mental states and adopting their point of view (Davis, 1994; Duan & Hill, 1996). The main distinction between cognitive and affective empathy is that whereas affective empathy involves the ability to share and respond to others’ emotional states, cognitive empathy involves the understanding of others’ mental states (Strayer, 1990). These two processes have been shown to have distinct neural underpinnings, which neuroscientists describes as two distinct ‘routes’ to empathy (Lockwood, 2016; Goldman, 2011).

Despite different neural architecture, most modern definitions of empathy involve both cognitive and affective components (Eisenberg & Eggum, 2009; Hodges & Klein, 2001). Kanske and colleagues (2015) suggest that successful social interactions require both affective and cognitive empathy. I agree and argue that both cognitive and affective aspects of empathy are valuable, but focus more on cognitive aspects of empathy. I favor empathic concern and other-directed empathy to avoid affect sharing to such an intensity that it can cause empathic over-arousal (Section 6.2).

1.4.3 DISPOSITIONAL-SITUATIONAL

Researchers have conceptualized and investigated empathy as both a dispositional and relatively stable trait rooted in one’s personality and as a situation-specific affective state. Measures of dispositional empathy provide a score for an individual’s propensity to empathize within a global index (i.e., the Interpersonal Reactivity Index developed by Davis, 1994). Measures of situational empathy assess the extent or amount of empathic responses extended towards a specific person or group of people in a specific situation. Crucial to this discussion is whether empathy is trainable.

1.4.3.1 Is Empathy Trainable?

Davis (1990) suggests that the process of empathy can be facilitated by developing other attitudes and behaviors related to a high quality of care, such as self-awareness, nonjudgmental positive regard for others, and active listening skills. This is the aim of virtual alterity projects. However, an individual’s situational (state) empathy may be independent from his or her dispositional (trait) empathy, and therefore dispositional empathy may constrain training situational empathy. Moreover, situational empathy facilitated in an experiment or VE may be only situational, with limited extended transformations in real-world prosociality. This is to say that the effects may only be temporary. To this point, Mel Slater’s team at EVENT Lab have addressed this concern in a longitudinal empirical study demonstrating the successful longevity of prosocial, positive intergroup attitudinal transformations after a VR simulation aimed to reduce racial biases (Banakou, Hanumanthu, & Slater, 2016).
1.4.4 Merging-Distinction

Theories of empathy are inconclusive in determining whether empathy is constituted by a heightened sense of similarity to and identification with the other (merging), or if empathy is based on a heightened awareness of the ways in which the other’s experience may differ from one’s own (distinction). On one side of the debate, several treatments of empathy in the literature highlight the self-other distinction (de Vignemont, 2006; Decety, 2011; Preston & de Waal, 2002; Singer, 2006; Lamm et al., 2007). On the other side, many theories of empathy argue that empathy is based upon a sense of identification with the other based on self-other overlap (Preston and de Waal, 2002; Sripida, 2005).

Robert Cialdini et al. (1997) created the Self-Other Merging (SOM) Model, which describes empathy as relational closeness with another based on subjective “oceanic” feelings of “oneness.” Aron et al. (1992) developed the SOM Scale, which involves a series of increasingly overlapping circles representing self and other to measure SO. Self-other overlap is the main hypothesized mechanism behind SOM models, which claims that empathy with others occurs by relating other’s experiences to one’s own. Self-other overlap permits identification with others. By contrast, the self-other distinction refers to the ability to distinguish the perspective of another from one’s own (Decety & Jackson, 2005). Evidence indicates that the preservation of self-other distinction is crucial for empathy (Decety, 2005), and neuroimaging studies suggests that psychological perspective taking (imagining how another would think and feel in a given situation) and the empathic concern it evokes are associated with self-other distinctions rather than self-other merging (Jackson, Meltzoff, & Decety, 2005; Lamm et al., 2007; Ruby & Decety, 2004). Batson et al.’s (1997) theoretical framework for empathy specifies that empathy-inducing instructions in perspective-taking tasks do not compromise the distinction between self and other.

In this thesis, I conclude that while empathy may involve overlap, sharing, or merging, it is crucial to preservation of the self-other distinction in order to differentiate one’s own emotions from that of a target, for instance. Instead of translating the other into one’s own self-model, I argue that empathy occurs by actively engaging with and attending to the other to gain information relative to the other’s unique perspective. Other-focused empathy allows for a heightened awareness of the other and more accurate readings of the other’s psychological and emotional stance (empathic accuracy). Hoffman (2008) stipulates that the mature capacity for empathy involves metacognitive processes to recognize how another person’s experiences might be different from your own. It can be argued that an empathizer cannot extend appropriate behaviors towards a target if the empathizer only understands the target by way of identification and self-other overlap.

1.5 Neurobiological and Bodily Empathic Processes

In this section I described shared representations and imitation, which involve automatic, implicit neurobiological and physiological activations based on perceiving the body and affect of another.

1.5.1 Shared Representations

Neurobiologist Vittorio Gallese (2003) claims that we recognize others as similar to ourselves based on the fact that the same neuronal activation patterns fire when observing another’s bodily or affective state as those that would fire when the perceiver undergoes those same states. This model suggests that cross-modal sensory integration processes allow us to map equivalences between self and other and form shared representations. Shared representations are overlapping areas of neural activation when perceiving the bodily or affective states of another that map onto representations of those same states in oneself. Shared representation are regarded as a subpersonal component to SOM, experienced phenomenologically as a sense of relational closeness.
Some theorists contend that we only have access to our own psychological experiences, and that self-knowledge is used as a template to project into others' psychological experiences analogy to our own internal states or prior experiences (Gordon, 1986; Barnes & Thaggard, 1997; Olson & Kamawar, 1999). However, if empathy is constituted by shared representations and internal simulations, then how does the empathizer also recognize another as distinct from oneself? Also, if empathy is constrained by shared representations then how can we understand and empathize with others who are different from ourselves?

Decety and Meyer (2008) describe empathy as grounded not just in perception-action coupling systems, but also in the ability to differentiate oneself from the perceived target based on a sense of agency and self- and other awareness. One of the main issues for self-other overlap, shared representation, and identification models of empathy is that these theories do not explain how an empathizer makes sense of a target experiencing something that is different from the empathizer’s own experience, attribution, or internal simulation (Gallagher, 2012). In this thesis my concern is that shared representations confound empathy with identification, and confuse self-other merging with self-other overlap, while missing important aspects of the awareness of another as a distinct subject sharing common structures of experience (intersubjective) in an interdependent social world.

1.5.2 Imitation

Imitation is a prosocial process that allows individuals to connect with one another, contributing to greater rapport and liking (Chartrand & Bargh, 1999; Lakin & Chartrand, 2003). Spontaneously imitating other’s observed mental or affective states is hypothesized to stimulate the first-person experience of that state (Preston & de Waal, 2002). Mimicry of facial expressions, posture, and mannerisms increases rapport and liking (Chartrand & Bargh, 1999), emotion recognition (Stel & van Knipperberg, 2008), and generosity (Van Baaren et al., 2003). Like shared representations, spontaneous imitation is decreased with out-group members (Gutsell and Inzlicht, 2010).

Hasler, Spanlang, & Slater (2017) conducted a VR study wherein users inhabited either a black or a white avatar and interacted with virtual agents of both skin colors. Regardless of the subject’s actual skin color, they found that subjects exhibited greater mimicry when interacting with virtual agents with same virtual body skin color than when interacting with a virtual agent of a different skin color as the subjects’ virtual body. This demonstrates that prejudices restricting spontaneous imitation may be malleable. In another VR setup, a virtual human representing an out-group was programmed to imitate subjects, and greater imitation increased intergroup empathy while conversing about a conflict (Hasler et al., 2014).

1.6 EMOTIONAL RESPONSES IN EMPATHY

In this section I first describe the notion of empathy as shared affect, which many researchers have taken up as a narrow definition of empathy. Then I describe aspects of affective responses to another person, explicating how these responses promote various empathic outcomes.

1.6.1 SHARED AFFECT

Many researchers have narrowly defined empathy to narrowly refer to emotional reactions that are at least broadly congruent with those of the target (Batson & Coke, 1981; Eisenberg & Strayer, 1987; Hoffman, 1981, 1987). Tania Singer, a neuroscientist who has pioneered research on the neural bases of empathy, consistently provides a lean definition of empathy as shared affect, or sharing another’s emotions or feeling what another person is feeling (see Singer & Lamm, 2009). This definition is intended to distinguish empathy from sympathy. By this definition, sympathy is a
vicarious emotional reaction that involves feelings of sorrow or concern for the other (feeling for someone), whereas empathy involves ‘feeling with’ someone defined through a similarity or isomorphism between the target and empathizer’s affective state. Shared affect must be modulated by appropriate attributions of whose emotions belong to whom (Decety & Jackson, 2005), which distinguishes empathy from emotional contagion. In emotional contagion, one feels what another is feeling but is not conscious of the origin of her own felt emotion as foreign.

For the purposes of this thesis, I contend that shared affect is not necessary for empathy. As Zahavi (2015) points out, an empathizer can be sad and concerned about a target’s frustration due to an injustice, for instance, while the target is angry, and still be empathizing even though these two affective states differ. Michael and Fardo (2013) propose that empathy involves an understanding of the intentional structure of an emotional experience rather than shared representations of internal states. Thus, in Zahavi’s (2008) example, the target’s emotion (frustration) is the intentional object of the empathizer even though the empathizer’s affective state (sadness) differs. In this thesis, empathy is understood in line with the phenomenological framework of Edith Stein (1989) as an intentionality that is directed towards the experience of another, and as involving concern for another rather just a direct equivalence or similarity of affect.

1.6.2 EMPATHIC DISTRESS AND EMPATHIC CONCERN: TWO DISTINCT RESPONSES

**Empathic distress** is a form of affect sharing and emotional resonance with another in distress. Empathic distress can sometimes be a prosocial motivator for people to quickly help another in distress, as they feel better when they help another (Hoffman, 1987, 2000; Eisenberg & Miller, 1987). Hoffman (1987) theorizes that empathic distress is a part of an early developmental self-oriented phase of emotional development and a precursor to more mature other-oriented empathy. When empathic distress is so strong that it requires a shift to one’s own distress, it can lead to personal distress. Personal distress is an aversive emotional state involving anxiety and unease that can be evoked in responses to another’s suffering, and it can be a barrier to other-focused empathy (Eisenberg & Strayer, 1987; Batson, 1991; Davis, 1994). Batson (1991) describes personal distress as “made up of more self-oriented feelings such as upset, alarm, and anxiety” (p. 117).

Research indicates that excessive personal distress can cause emotional fatigue and inhibit or block empathic attitudes and behaviors (Batson, Fultz, & Schoenrade, 1987). Emotional fatigue is related to what Hoffman (2008) terms “empathic overarousal”, a condition in which one’s emotional resonance with another or apprehension of another’s distress causes so much distress in the empathizer that the empathizer becomes more self-focused than other-focused. Thus, the need to alleviate one’s own distress could saturate excess energy resources to alleviate the other’s distress. Thus, if an individual is too personally distressed by witnessing another’s distress, then he or she may be unable to act towards the other based on this emotion. To demonstrate this phenomenon, Strayer (1993) showed children ages 5-13 years short film clips of distressed children in various situations: one was forcibly separated from a parent, one was unjustly punished, one struggled to climb stairs due to a physical disability. The children’s distress escalated in relation to the distress of the distressed children in the film clips until subjects’ empathic distress reached the same level, in which case the children's focus shifted to themselves.

**Empathic concern** is an other-focused emotional response that involves concern for another’s welfare. Recently, Singer and Klimecki (2014) align Batson’s (1991) definition of empathic concern with their definition of and findings pertaining to compassion. Singer and Klimecki (2014) has aligned Batson’s (1991) definition of empathic concern with their definition of and findings pertaining to compassion. Empathic concern has been also labeled sympathetic concern by de Waal (2008), and matches Scheler’s (1954) definition of sympathy. Singer and Klimecki (2014) define compassion as “…feelings of warmth, concern and care, as well as a strong motivation to improve the other’s wellbeing.” (p. R875) This definition of compassion is importantly distinct
from empathic distress since compassion is linked to positive affect, whereas empathic distress can trigger negative affect.

Empathic distress and empathic concern have inverse effects on prosocial outcomes (Batson, Fultz, & Schoenrade, 1987). Empathic distress is generally conceived as a barrier to prosocial motivations, attitudes, and helping behaviors (Batson, Ahmad, Lishner, & Tsang, 2002). By contrast, Empathic concern motivates prosocial, altruistic attitudes and behaviors and is strongly linked to helping (Batson, 1991; Davis, 1994; Oswald, 1996). Empathic distress is more self-focused, and empathic concern, sympathy are other-focused emotional responses. This is an important distinction for my aims in this thesis since my definition of empathy crucially specifies empathy as other-focused.

McGonigal (2016) explains that during compassion, one’s awareness of his or her own suffering fades into the background as concern for another foregrounds. This is the inverse of what seems to occur with empathic distress. Thus, when confronted with another's suffering, empathic distress would involve sharing the other's suffering and hence the associated negative affect, whereas compassion would involve feelings of warmth, lovingkindness, and concern with a strong motivation to alleviate the other's suffering (altruistic motivation). Batson (1987) claims that empathic distress could conflate the egoistic motivation to alleviate one’s own personal distress with the motivation to alleviate the target’s distress. Compassion often inhibits one’s own emotional responses, specifically of fear, stress, and anxiety, while one focuses attention on another in a caring way (McGonigal, 2016). Decety and Meyer (2008) suggest that executive functions for emotional regulation are important in empathy.

Tusmørke’s (2014) VR project Autumn1, centering around a woman (named Autumn) recovering during the aftermath of an assault and attack, borders on this line between empathic concern for the main character and personal distress experienced by the user (Figure 1). Importantly, Tusmørke designed Autumn in a level-based way such that the player controls Autumn’s actions and helps Autumn heal and overcome her fears while she faces flashbacks and seeing her perpetrator in random strangers. Thus, the player has an active role in alleviating Autumn’s distress, trauma, and suffering, while vicariously sharing her plight. This is an innovative way to combine affect sharing with prosocial helping behavior. The gamification of the VR project aids in the motivation to help Autumn, but also allows the user to not remain in a state of empathic distress.

The bottom line is that whereas shared affect and empathic distress do not definitively produce prosocial changes, empathic concern does. Thus for the purposes of this thesis it is important to understand empathy as a process that stimulates empathic concern, as this emotional response is more conducive to facilitating empathic outcomes demonstrating the effects of training. Moreover, it is important that VR interventions do not arouse too much empathic distress, as this can tax the user’s resources to extend the appropriate other-directed prosocial attitudes, motivations, and behaviors.

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1 https://youtu.be/M-Dqyt1Ewo
1.7 **COGNITIVE EMPATHY**

This section describes various features of cognitive empathy, including perspective-taking, role-taking, and narrative engagement. Cognitive empathy is often measured by the accuracy with which an empathizer can assess the thoughts and feelings of a target (empathic accuracy, see Ickes, 1997). The reason that cognitive empathy is important for this thesis is that it specifies capacities that aid interpersonal understanding to better service VR as an empathic training simulator. For the purposes of this thesis, the most important feature of cognitive empathy is perspective-taking, which Batson (1991) acknowledges as an important source of human empathy and is a cognitive process that can be externally represented and scaffolded in VR.

1.7.1 **VISUAL PERSPECTIVE TAKING**

The term “perspective” originates in optical science and is intended to refer to the structured account of a visual scene from a specific physical orientation, scale, axis, angle, and viewpoint. Visual perspective taking (VPT) involves imagining a visual scene spatially structured in relation to another person’s viewpoint versus one’s own (egocentric) viewpoint (Zacks & Michelon, 2005; Wraga & Shepard, 2005). Baron-Cohen and Wheelwright (2004) claim that this capacity is closely related to empathy, which is supported by neuroimaging studies which show overlap between regions involved in visual perspective taking and empathic demands (Decety & Lamm, 2007), particularly in the temporoparietal junction (TPJ).

Michelon & Zacks (2006) specify two levels of VPT: Level 1 involves computing another person’s line of sight to cognitively connect to what another person sees, and Level 2 involves understanding how an object or scene would appear from another person’s embodied position. Level 1 involves recognizing another person’s gaze cues to compute what and where another person is looking based on following another’s line of sight (Kessler & Rutherford, 2010). Object Theory, an application developer for the Microsoft Hololens, created a collaborative virtual environment that presents gaze lines between remote users (Figure 2) so that users can follow each others’ gaze.

While especially useful in team collaborations and education, research on gaze pointing does not seem to promote empathic outcomes. Masai, Sugimoto, Kunze, and Billinghurst (2016) created “Empathy Glasses”, a device that allows two people to complete tasks together while sharing visual field of view and gaze information. In this setup, a “remote helper” shares gaze cues with a “local user” (Figure 3). While helpful in solving the task, gaze pointing

![Figure 2](http://www.objecttheory.com)

**Figure 2.** Stills from Object Theory’s collaborative virtual environment for Microsoft Hololens using gaze lines. Image from http://www.objecttheory.com

![Figure 3](http://www.objecttheory.com)

**Figure 3.** Masai et al.’s (2016) “Empathy Glasses” setup, where a remote user (left) uses a gaze pointer to help a local user (right) solve a puzzle.
did not increase the local user’s ability to recognize the thoughts and emotions of the remote user.

Level 2 VPT involves projecting one’s own body into the place of another, which Thirioux et al. (2014) distinguishes as a hetero-centered framework versus an egocentric framework. There are two strategies for visuospatial perspective taking: one is a spatially oriented (left-right transposition) strategy, and the other involves mentally transforming one’s own body to align with the body of another person, which is called own body transformation (OBT). Mentally transforming one’s own body to align with another person’s body is linked to greater trait (dispositional) empathy scores (Gronholm et al., 2012). In VR, users can see scenes and interactions unfold from multiple different points of view, which is called multilateral perspective taking (Bailenson, 2006), providing an external tool to facilitate cognitive perspective taking and OBT processes (Figure 4).

Perspective taking involves self-transpositional, which is imagining seeing from another’s viewpoint and also imagining seeing oneself from another’s perspective (Davis, 1994). VR setups can directly simulate self-transpositional. This means that an individual will have an interaction with another real person, character, or virtual agent and then swap and see the same interaction from the other perspective of the other person, seeing themselves or their previously embodied avatar or character interact with the other person(s), character(s), or virtual agent(s). For example, Raij, Kotranza, Ling, & Lok (2009) developed a medical interview training application to help medical students be more empathic towards patients. The medical students interview and examine a patient called Amanda, a virtual human who expresses fear about a persistent pain in her breast indicating she may have breast cancer. The doctors conduct the medical interview and breast examination in VR from their own point of view, and then see the entire interaction from Amanda’s point of view.

1.7.2 Social Perspective Taking

Moll and Meltzoff (2011) define perspective taking as also understanding that others may see things in a different way. Perspectives often originate from subjective persons, so perspective taking is not just about what is visible from a certain orientation or viewpoint but also the thinking and feeling behind that viewpoint (Lindgren, 2012). So adopting another person’s perspective also involves delving into the way that person thinks and feels about a situation. A crucial component to this is the notion of stepping into the “mental shoes” of another to imagine how others feel about an object, or event. For example, in Raij et al.’s (2009) medical interview training, specific empathic moments were designed to help the student understand Amanda’s fears during the interview and breast examination. The VR setup is designed to assist students in reflecting on their communication skills and to aid empathic listening to patients. Thus, rather than just seeing from Amanda’s point of view, the students are encouraged to contemplate her thoughts and emotions.

Social Perspective Taking (SPT), also called role-taking, is a cognitive empathic process in which an empathizer discerns the thoughts, motivations, and feelings of a target (Davis, 1996; Gehlbach, Brinkworth, & Wang, 2012). SPT involves reflecting on a situation from the point of view of another person and interpreting others’ behaviors (Gelbach, 2017). SPT aids interpersonal understanding and effective communication (Johnson, 1975; Krupat, Frankel, Stein, & Irish, 2006). Individuals who are better at SPT and who engage in it more often are less likely to negatively stereotype others (Galinsky & Moskowitz, 2000) and respond less aggressively when provoked (Richardson et al., 1994). Stronger SPT capacities also help people better understand, appreciate, and develop positive relationships with individuals who have value and belief systems that diverge from their own (Gelbach et al., 2015). Social perspective-taking has been demonstrated to aid in conflict

Figure 4. Image from Bailesnon (2006) depicting multilateral perspective taking in VR, where a user can inhabit her own embodied perspective (A) or the perspective of a conversational partner (B).
resolution (Deutsch, 1993), promoting cooperation (Johnson, 1975) and reducing bias (Galinsky & Moskowitz, 2000). Computer games and VR have been used to simulate social interactions in conflict resolution (Kampf & Cuhadar, 2015), cultural competency (Deaton et al., 2005), and medical diagnosis (Raij et al., 2007).

However, sometimes SPT backfires and reinforces pre-existing stereotypes (Skorinko & Sinclair, 2013). High in-group affiliation and allegiance may be one factor that impacts SPT as an intervention with negative consequences (Tarrant, Calitri, & Weston, 2012), especially if the target exhibits physical features, value systems, or behaviors that are consistent with and therefore confirm the perceiver’s negative stereotypes (Skorinko & Sinclair, 2013). Moreover, competitive atmospheres increase perceived threat, which can lead to increased prejudices towards others who are perceived as threatening. Therefore, cooperative (rather than competitive) training situations are important for SPT and conflict resolutions to be effective as an intervention for conflict resolution (Piece, Kilduff, Galinsky, & Sivanathan, 2013). For this reason, virtual alterity projects use only cooperative tasks.

1.7.3 NARRATIVE ENGAGEMENT

Narrative engagement refers to the linguistic mediation of empathy through communication. This specifies how meaning gets communicated from one person to another within the context and situation of an experience. Hoffman (2008) writes, “...one’s empathy may first be aroused by the relatively quick-acting preverbal modes and then fine-tuned by semantic processing” (p. 442). Narratives allow us to understand the context of another person’s affective and cognitive situation, and to also tap into how an experience is personally meaningful for them. When a person’s affective state is communicated through language, we can construct visual or auditory images of their experiences. When these images are provided by film or VR, narrative engagement is enriched and can potentially tap into deeper signification and context for a narrator’s affective states. VR is capable of eliciting a stronger sense of presence in a virtual world than traditional forms of media, and this is linked to stronger emotional responses (Tamborini et al., 2004; Riva et al., 2007).

Chris Milk’s (2016) Clouds Over Sidra3, for instance, is a 360 degree VR video showing aspects of a young Syrian refugee's daily life with images of Syria and the refugee camp. The video is narrated by her as she tells her story but it does not explicitly use any point-of-view (POV). The audience can look around and see events depicted by the narrator’s voice-over.

1.7.4 EXPERIENTIAL PERSPECTIVE TAKING

In VR, people can now directly step into the “digital shoes” of another person or avatar (embodied simulations). This has demonstrated transformed perceptions of others towards more positive and affiliative attitudes (Yee & Bailesnon, 2006). However, embodied simulations lack information about the specific person who the subject embodies and situational context. Gehlbach et al. (2015) found that giving subjects more information about another person’s perspective on a situation led to greater compromise in favor of the other person’s views in a negotiation task. This is where virtual alterity projects attempt to get closer to Experiential Perspective Taking, understanding another not just by seeing from their point of view but also learning about the person who is behind the view and how he or she experiences events. While audiences watching 360 videos reveal information about a person behind a view and may feel sense of presence in the world of the narrator, the audience is anonymously present in the scene, non-participatory, and disembodied. This is a distinction I make in virtual alterity projects, where users actually embody another person and participate in an activity together while being guided into aspects of the other person’s perspective.

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3 https://with.in/watch/clouds-over-sidra/
I further discuss virtual alterity projects and experiential perspective taking in Chapter 3. Now, I explain the phenomenological approach to empathy, which grounds my design and research aims for virtual alterity projects.

1.8 **Phenomenological Approaches to Empathy**

In this thesis, I define empathy as a heightened awareness of another as a subjective person and agent acting within an intersubjective, shared social world. This is highly aligned with Edith Stein’s (1989) conceptualization of empathy, as well as other phenomenological writings on empathy from Scheler and Husserl. In this sense, empathy involves the recognition that subjectivity is an experience that other subjects also experience, that we are “unique in the same way” (Zahavi, 1991, p. 164). Thompson (2001) writes that phenomenological analyses of empathy are grounded on the idea that self and other recognize each other first and foremost as persons. One component to this is intersubjectivity, the sense of self and other as interconnected and reciprocally constituted by and through social interactions. Thus, in this thesis I argue that a mature form of empathy involves a recognition of another as a *subject* with similar structures of first-person experience and bodily expressions that signify a unique personal and social identity. This is something that I refer to as ejective consciousness, borrowing Baldwin’s (1897) term. Moreover, we experience other’s bodies as signifying and expressing their subjectivity. Through other-directed intentionality and other-focused perspective-taking, the other can be apprehended in his or her distinctness. The issue is that much of the time, others are not grasped in their subjectivity but are instead rapidly dismissed based on perceived differences or convenient categorizations (stereotypes, prejudices, in-group and out-group, etc.). Instead, Edith Stein (1989) suggests, “…we may turn toward the foreign experience [of the other] and feel ourselves led by it.” (p. 19) VR offers a compelling tool to facilitate perspective-taking and simulating other’s first-person experiences, and thus my claim is that it can cultivate deeper forms of engagement with others through both their distinctness and commonality.

1.8.1 **Intersubjectivity**

Intersubjectivity is defined by Jensen & Moran (2012) as “the ability to share the subjective states of others and resonate with their perspective” (p. 1054) and involves an intersection and interplay of two subjectivities. Edith Stein (1989) writes, “The perceived world and the world given empathically are the same world, differently seen.” Zahavi (1991) claims that the ego is constructed in relation to the other, who acquaints us with new aspects of our being, and we likewise reveal to the other unseen or previously unaware aspects of her Being. Zahavi (1991) writes, “The ego is only fully individualized when personalized, and this only happens intersubjectively. I only become a personal ego through my life with Others in our communal world.” (p. 166) Self and other co-determine one another in intersubjective accounts of empathy (Thomson, 2001). Pagotto (2010) writes that self-identity is formed and fostered alongside social identity. Thus, in this thesis I argue that a mature form of empathy involves a recognition of another as a *subject* with similar structures of first-person experience and bodily expressions that signify a unique personal and social identity.

1.8.2 **Ejective Consciousness**

Baldwin (1897) uses the term “ejective consciousness” to describe the experience of recognizing the subjectivity of others, suggested as a process of moral development in children, and writes, "other people's bodies, says the child to himself, have experiences in them such as mine has" (p. 8). Psychoanalyst Jennifer Benjamin’s (2004) theory of mutual recognition situates empathy within the experience of another person as a similar subject with a distinct, separate center of
emotion and perception, and this is the self-other relation I regard as most crucial for empathy. In this thesis, I argue that empathy involves a deeper recognition of the other as a subject like oneself.

In Husserl’s (1989) writings, the body of the other is perceived as a living body, something that is alive (Leib), bearing experience like our own, rather than as a material object (Körper). Gallese (2003) writes, “Empathy is deeply grounded in the experience of our lived body, and it is this experience that enables us to directly recognize others not as bodies endowed with a mind but as persons like us.” (p. 176) Edith Stein (1989) writes that in empathy the other “…is not given as a physical body, but as a sensitive, living body belonging to an ‘I’, an ‘I’ that senses, thinks, feels and wills. The living body of this ‘I’ not only fits into my phenomenal world but is itself the center of orientation of such a phenomenal world. It faces the world and communicates with me.” (p. 5) Thus, empathy involves more than shared representations but also insight into what the other’s bodily expressions signify in terms of his or her subjective states.

Gallese (2003) describes empathy as involving our process to “identify others as intentional agents” (p. 171). This definition of empathy is one that I take to be quite central to the virtual alterity systems I describe in this thesis. Decety and Jackson (2005) write that “individuals must be able to disentangle themselves from others” in order for self- and other overlap of representations to not lead to personal distress. They conclude, “Therefore, agency is a crucial aspect of empathy.” (p. 56) In this thesis, I suggest that agency may be a valuable factor in empathy and highlight findings from virtual alterity projects that disrupt one’s normal sense of agency towards shared agency. At the same time, virtual alterity setups enhance recognition of another as an intentional agent by watching actions performed by the other that are spatially congruent to one’s own actions and yet also distinct. I discuss these findings more in Chapter 3.

1.8.3 Other-Focused Perspective Taking

Hoffman (2008) describes three different types of affective and cognitive perspective taking in empathy: self-focused, other-focused, and self-and-other focused. Self-focused perspective taking involves vicarious transfer of emotionally impactful stimuli affecting a target by imagining oneself being affected by the same or similar situation. Self-focused perspective taking evokes an emotional response that could be enhanced by association with similar events in one’s own past. Batson, Early, and Salvarani (1997) found that self-focused empathy is linked to more intense empathic distress. Other-focused perspective taking involves attending to another person’s feelings, current life condition, and behaviors, as well as bodily expressions in the other person’s face, eyes, voice, and posture. Self-and-other directed perspective taking involves combined effects of the emotional intensity from self-directed perspective taking with sustained attention to the other as parallel processes. Virtual alterity projects aim to accomplish an other-focused empathy, and The Machine to Be Another represents an example of self-and-other focused empathy. Zahavi (2008) writes, “In empathy, the experience you empathically understand remains that of the other. The focus is on the other, and not on yourself, not on how it would be like for you to be in the shoes of the other. That is, the distance between self and other is preserved and upheld.” (p. 291) This is crucial in my critique of avatar embodiment studies.

Importantly, other-focused empathic concern and self-focused empathic distress produce different motivational consequences. Batson et al. (1997) conducted a study in which subjects listened to a radio interview tape of a young woman in serious distress. Subjects were divided into three groups with different sets of instructions while listening to the tape. The first group were told to remain objective, the second group were told to imagine how the young woman felt (other-focused empathy), and the third group were told to imagine how they would feel in the young woman's situation (self-focused empathy). They found that subjects in both imagination conditions experienced empathy, but that it had differential consequences. Other-focused empathy that involved imagining how the young woman felt evoked empathy linked with empathic concern and altruistic motivation, and self-focused perspective taking that involved imagining how they would feel evoked empathy but also produced empathic distress, which is linked with egoistic motivation.
CONCLUDING REMARKS

Based on the above discussion, there are two main definitions of empathy that I will use throughout this thesis. The first is to understand empathy as other-directed empathic concern involving feelings of tenderness and sympathy. These feelings motivate positive attitudes of respect and inclusivity towards the other or the other's group, as well as behaviors exhibiting a desire for the positive well-being of the other person or group. The second way that I define empathy is as a heightened state of attunement to another person amidst an experience of interconnectedness wherein the empathizer is simultaneously aware of another person as a subject and aware of oneself as partly constituted in relation to others. I rely on these definitions as central to framing how VR can facilitate empathy and propose limitations in current research and projects towards these aims.
Chapter 2:
Embodied Simulations in Virtual Reality

2.1 INTRODUCING EMBODIED SIMULATIONS

This chapter describes embodied simulations as one method for facilitating empathy in VR. Embodied simulations (Bertrand et al., 2014), also sometimes called “embodied experiences” (Ahn, Le, & Bailenson, 2015) or “virtual embodiment” (Peck, Seinfeld, Aglioti, & Slater, 2013), are virtual environments in which users experience being in a different body from a first-person perspective. For the purposes of this thesis, I divide embodied simulations into two types: embodying an avatar (avatar embodiment) and embodying a real person (virtual alterity). This chapter focuses on avatar embodiment.

The theory of empathy in avatar embodiment studies is that barriers to empathy can be overcome by altering perceived similarity, self-other overlap, and identification with an out-group other. These barriers to empathy are based on intergroup biases, a phenomenon deeply embedded in our brains and in society (Amodio, 2014; Molenberghs, 2013). Research indicates that intergroup bias can block certain automatic empathic processes such as spontaneous mimicry and neurological responses in vicarious pain (Aventi, 2010). Intergroup biases are also observed in racism, often related to the lack of empathy (Cosmides et al., 2013). Avatar embodiment studies foster empathy by way of identification with the other without highlighting the ways in which another person’s experiences, thoughts, and emotions may differ from one’s own (self-other distinctions). Avatar embodiment studies measure empathic outcomes through attitude changes, specifically decreases in negative implicit out-group biases and increases in positive implicit attitudes towards outgroups.

This thesis proposes an alternative design for facilitating empathic processes and outcomes in VR using embodied simulations with real people under a project entitled “virtual alterity” to highlight the self-other distinction as a primary focus. Virtual alterity systems implement other-focused perspective taking and empathy in VR. Alterity is understood in the anthropological literature on empathy to indicate the importance of maintaining an awareness of the other as distinct from oneself, specifically when attempting to understand others who have very different cultural heritage and practices, value systems, lifestyles, mental or physical abilities, etc. (Gadamer, 1960; Rothfuss, 2009). I argue that recognizing and appreciating another’s alterity is important for empathy, and propose virtual alterity systems as a tool for this interpersonal exchange. Rather than just seeing the other as like oneself, virtual alterity systems facilitate empathy through heightened awareness of another as bearing a distinct subjective experience. Cognitive neuroscience research identifies the matured capacity for empathy as being able to recognize other people as distinct from, yet similar to oneself (Decety, 2005). Virtual alterity systems are designed with this in mind. Because avatar studies involve seeing and imagining oneself as the other (self-focused perspective taking) rather than seeing and imagining the other’s experience (other-focused perspective taking), avatar studies are not other-focused and do not highlight ways that another’s experience may differ from one’s own. Regardless, avatar embodiment studies provide the groundwork for design utilized in virtual alterity systems and offer compelling findings as a starting point for facilitating empathy in VR.
2.2 EMBODIED SIMULATION SETUPS

2.2.1 AVATAR EMBODIMENT SETUPS

Avatar embodiment studies incorporate motion tracking to induce visual-motor synchrony while participants take on a first-person perspective of an avatar body. Participants wear motion-capture bodysuits and VR head-mounted displays (HMDs) within a 2 x 2 M physical walk-around space. Users embody an avatar, a computer-generated representation of a person, such that when they look down they see the virtual torso, legs, and feet of the avatar body. A motion-capture bodysuit and motion tracking systems track and render the user’s physical movements onto the virtual body so that users can move the avatar body and walk around the virtual world. Users also see the avatar body reflected within a virtual mirror (Figure 1). Avatar embodiment has become one of the major paradigms in VR research labs. Figure 5 shows the setup used in avatar embodiment studies. This image is of Peck et al.’s (2013) study, which showed that experiencing a sense of ownership over a dark-skin avatar body reduced implicit racial biases in white participants.

2.2.2 VIRTUAL ALTERITY SETUPS

Virtual alterity systems use video-generated virtual environments to allow a user to embody another real person (Figure 6). Like avatar embodiment, virtual alterity systems use synchronized touch and movement and sometimes also a mirror so that the user can see themselves reflected as another person. One such setup, The Machine to Be Another (MBA), is an art performance installation inspired by neuroscience protocols for bodily and perceptual illusions designed to trick the brain’s perception of one’s own body (BeAnother Labs, 2014; Bertrand et al., 2014). MBA is based on research that combines art, cognitive sciences and accessible technology. Presentations of MBA have been fascinating participants, especially enthusiastic when between 6 and 20 years old, in places like Mexico, Spain, Slovenia and Israel. The MBA has been applied in issues such as mutual respect, generational conflicts, gender identity, immigration, and physical disability bias.
The Machine to Be Another Classic Setup

The MBA classic setup is designed with a “performer” wearing a front-facing (either head or chest-mounted) camera recording video that is live streamed into the virtual reality headset of a “user” (Figure 7). This allows two people share a first-person perspective simultaneously. The MBA classic setup is an embodied simulation that puts the user in synch with another person by sharing bodily comportments and movements, creating the illusion of embodying another (real person). In the MBA classic setup, the “performer” imitates and follows the movements of the “user”, creating a visual-motor synchrony effect.

The Machine to Be Another Body Swap

The MBA Body Swap is a setup in which two individuals wear an Oculus Rift Developer Kit 2 VR head-mounted display (HMD) with a camera mounted on front to see from one another’s embodied point-of-view in a live video stream (Figure 8). In Phase 1, there is a curtain separating the two users. Two facilitators perform coordinated movements so that the users receive synchronous visual and touch stimulation on the hands, arms, and feet to induce a Body Ownership Illusion (BOI) in the body of another. Users are instructed in an imitation procedure (Dumas et al., 2010) to move very slowly and to try to move with their partner, resulting in intervals of turn-taking and spontaneous synchrony. In Phase 2, the curtain is removed and the facilitators guide the users to stand up, walk towards one another, and shake hands (Figure 9). Because the experience is a body swap, this involves seeing oneself from the point of view of the other user. When the two users meet, the facilitators guide the users to shake hands and provide synchronous stimulation to the arm, wrist, and hand of each user to induce a subtle BOI while the user sees themselves from the other’s point of view.
**Paint With Me**

The MBA classic setup inspired *Paint With Me* (PWM), a virtual environment where users see a video from a painter’s embodied point of view with a tracked rendering of their own hand (using Leap Motion) while they listen to the painter describe her creative process and follow the painter’s movements on their own physical canvas (Figure 10). The setup uses stereoscopic video (filmed with two Go Pro Hero 4 cameras and stitched in Autopano) displayed into an Oculus DK2 VR headset, Roald binaural microphones worn by the performer and played into headphones worn by the user to capture audio from the painter’s point-of-view, and the Leap Motion to capture the user’s hand motion. Users see a tracked rendering of their own hand on top of the video of the painter, such that the user can move their hand in tandem with the painter and follow her movements while painting along with her.

**Figure 10. The Paint With Me Setup.** Whereas in the MBA classic setup the performer follows the user’s movements, in PWM the user follows the movements of the performer (the painter). Figure from Gerry (2017).

2.3 **HOW EMBODIED SIMULATIONS FACILITATE EMPATHY**

Laboratory experiments have demonstrated that body perception can be altered through perceptual illusions inducing multisensory conflict (Aspell, Leggenhager, & Blanke, 2009; Aspell et al., 2006). These experiments indicate that representations of the body, including the relative size, location, and appearance of the body and its parts, may be malleable. Through perceptual illusions, external objects such as rubber hands, mannequin bodies, and virtual body parts or whole bodies may be incorporated into one’s body image. The body image is one’s mental model of their own body and its features as distinct from other objects and bodies. One such perceptual illusion is the Body Ownership Illusion (BOI), or the sense of owning a body different from one’s own real body. When the BOI is induced with a virtual body representing an out-group, this produces more positive appraisals of and attitudes towards out-groups. The key hypothesis is that incorporating features of an out-group member into one’s own body image can alter higher-level social perceptions, change implicit attitudes, and make people more empathic toward the outgroup.

VR can induce embodiment by creating multi-sensory stimuli combining first-person perspective with synchronous visual and tactile stimuli, as well as visual and motor synchrony (Maselli et al., 2013). In avatar embodiment studies, the BOI is hypothesized to be a mechanism for increasing self-other overlap of body representations (shared representations). Virtually embodying an out-group avatar body causes subjects to include features of the body of an out-group member into their own body image, impacting conceptual self-other overlap (Maister et al., 2013). Maister et al. (2013) write, “We argue that these [social attitude] changes occur via a process of self-association, first in the physical, bodily domain as an increase in perceived physical similarity between self and outgroup member, and then in the conceptual domain, leading to a generalization of positive self-like associations to the outgroup.” (p. 9) The key motivation behind avatar embodiment studies is to experimentally manipulate body representations by inducing body ownership illusions over an avatar body representing an out-group member. This is a technique to increase inclusion of out-group members. Avatar embodiment studies have demonstrated embodied simulations as a successful tool for reducing negative implicit biases and promoting positive attitudes for stigmatized out-groups. These studies induce self-other merging (SOM) by way of identification with an out-group.
First, I describe the mechanisms currently deployed in avatar embodiment studies through a history of findings regarding the malleability of bodily self-consciousness in Out-of-Body illusions and Body Ownership Illusions. This malleability is the cornerstone of experimentally altering shared representations, and it informs design possibilities within virtual environments.

2.4 History of Laboratory Body Illusions

VR causes a user’s perception of their body to be re-oriented around a new, virtual perspective within a virtual world. These effects are optimized based on research on bodily illusions that impact bodily self-consciousness. Bodily self-consciousness involves non-conceptual and pre-reflective representations of the body (Gallagher 2000; Haggard et al. 2003). The components of bodily self-consciousness that have been empirically studied in VR include: self-location, body ownership, and perspective (Serino et al., 2013). Jeannerod (2007) includes sense of agency (SoA) as an aspect of bodily self-consciousness, agency illusions in VR may impact a user’s sense of agency. Normally one’s experience of these aspects of bodily self-consciousness are unified, but research indicates that this unity can be disrupted through specific types of multisensory stimulation and perceptual illusions (Mandrigin & Thompson, 2015). Bodily self-consciousness involves the awareness of oneself as the sole subject of one’s primary, bodily experiences (Corona, 2013). Thus bodily self-consciousness has a special privacy and primacy, but VR can allow two people to share aspects of one another’s bodily self-consciousness.

The sense of being located at a specific point in the environment is called self-location, and pertains to the question, “Where am I in space?” (Ionta et al. 2011). Self-location refers to the experience of conscious awareness centered within the body and of having a body that takes up space within the external physical environment. Another aspect of bodily self-consciousness is self-identification, which involves the recognition of one’s body or body parts as one’s own, as separate from other objects and other bodies, and as belonging to oneself (body ownership). Tsakaris (2010) defines body ownership as the feeling that the body a person inhabits is one’s own, an integral part of ‘me’, in ways that other objects and other people are not. In laboratory experiments, multisensory stimulations and perceptual illusions can alter a subjects’ perceived self-location (creating an out-of-body illusion) and their self-identification, leading to a sense of ownership over an illusory body, or a body ownership illusion (BOI; Guterstam & Ehrsson, 2012). These studies allow scientists to investigate the nature of the bodily self, and how the experience of the body as mine is developed, maintained, or disturbed (Tsakiris, 2010). Serino et al. (2013) stipulate perspective as the first-person, body-centered locus of access and orientation within an environment. The first-person perspective involves the question, “From where do I perceive the world?” (Ionta et al., 2011). Perspectives can be uniquely manipulated within virtual environments (VEs) by pairing self-location and self-recognition to a new perspective. Sense of Agency (SoA) is the feeling of authorship for self-generated movements and the external events they cause (de Vignemont & Fourneret, 2004). Motion tracking in VEs allows users to have a sense of agency over actions and events within the virtual world, creating agency illusions that reinforce and strengthen BOIs.

Experimentally manipulating body ownership has important consequences for social perception and inclusivity. Empathy research in VEs use a first-person perspective (1PP) on a virtual body to induce a full body ownership illusion (FBOI) such that users experience an avatar body as their own. Users see their avatar body spatially aligned with the user’s visuospatial first-person perspective and matching their movements. First, I review the history on bodily illusions in order to explain how these laboratory findings developed into the paradigms currently used in VEs designed to promote empathy.
2.4.1 The Rubber Hand Illusion

Experimental research on OBEs and BOIs is inspired by the protocol used in the Rubber Hand Illusion (RHI; Botvinick & Cohen, 1998). The RHI is an experiment that causes subjects to experience an external object (a rubber hand) as part of their own body (body ownership). Subjects sit at a table, place their real hand on the table such that it is hidden from view behind a dividing panel, and see a rubber hand placed on the visible side of the divider (see Figure 7). The illusion occurs as the experimenter either taps or brushes the subject’s real hand and the rubber hand synchronously with a rod, and after about 15-20 seconds most people start to experience the rubber hand as though it were their own hand. This effect is measured qualitatively, after the illusion (post-induction), through a self-report Likert Scale Ownership Illusion Questionnaire, with items such as “I felt as if the rubber hand were my hand” (Botvinick & Cohen, 1998). The RHI has been used as a tool for the inclusion of out-group members under an “inclusion of the other in the self” model (Aron, Aron, & Smollan, 1992) by eliciting an experience of an out-group skin color rubber hand as one’s own.

The RHI is also measured quantitatively through a strong physiological and psychological response when the experimenter stabs the rubber hand with a knife (the knife threat paradigm), eliciting physiological skin conductance responses as though one’s real hand were threatened. Another quantitative response is to measure the distance between the felt position of the hand as blindly pointed out by the participant after the illusion, causing changes in perceived self-location towards the fake hand called proprioceptive drift (Aspell et al., 2009). The RHI works by pairing visual information with synchronous tactile information to create multisensory integration between the seen rubber hand and felt real hand. This causes the brain to confuse the cross-modal sensory signals, misidentifying the rubber hand as the source of the felt haptic sensation. This effect is described as the “spatial remapping of touch” (Botvinick, 2004; Ehrsson et al., 2004; Ehrsson et al., 2005). Importantly, the illusion is significantly weakened by or ineffective with asynchronous tactile stimulation. The RHI has been replicated within VR; Subjects experience a virtual arm as part of their body when tactile stimulation is applied synchronously to their unseen real arm and the seen virtual arm (Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2008).

There are certain constraints to the RHI; it requires synchronous stimulation, and it only works with hand-shaped objects. The effect will not work with just a wooden block, for instance (Tsakiris, Carpenter, James, & Fotopoulou, 2010). Morphological similarity and corporeality of the rubber hand influences the illusion of body ownership (Haans, Ijsselsteijn, & de Kort, 2008). Greater discrepancies between the posture and spatial position of the rubber hand relative to the subject’s real hand diminish the BOI effect (Austen, Soto-Faraco, Enns, & Kingstone, 2004; Lloyd, 2007). Thus, the rubber hand must be spatially congruent with one’s real hand from a first-person perspective (Pavani, Spence, & Driver, 2000). Interestingly, the premotor cortex becomes activated as subjects begin to identify the rubber hand as their own hand (Ehrsson, Spence, & Passingham, 2004). During the illusion, physiological reactions such as decreased temperature of the subject’s real hand (Moseley et al., 2008; Hohwy & Paton, 2010) and changes in temperature sensitivity thresholds (Llobera, Sanchez-Vives, & Slater, 2013) indicate a body transfer effect. The strength of the BOI can be tested where the illusory body is harmed with a knife, or by other means, evoking physiological
responses and neural responses that mimic the anxiety response to a threat to one’s own real hand (Ehrsson et al. 2007). Physiological findings in response to threat to a fake hand indicate that subjects have some degree of transfer towards the fake hand, an effect that Guterstam and Ehrsson (2012) refer to as “disownership.”

2.4.2 VIDEO-BASED BODILY ILLUSIONS BASED ON THE RHI

Laboratory-evoked OBEs and BOIs inspired by the RHI include experimentally induced out-of-body illusions (Ehrsson, 2007) and full-body illusions (Legenhager et al., 2007), and body swap illusions (Petkova & Ehrsson, 2008). These illusions both involve synchronous stimulation presented through two sensory streams, causing a perceptual illusion whereby a subject can experience him or herself at different point in space (illusory self-location) and out of his or her own real body (illusory body ownership), such as in a mannequin or another person’s body. Subjects in these bodily illusions react to peri-personal space around the new bodily axis point of multisensory integration (Ehrsson, 2007; Lenggenhager, Tadi, Metzinger & Blanke, 2007). These illusions create the foundation for effects used in embodied simulations in VR.

THE OUT-OF-BODY ILLUSION

The ‘out-of-body illusion’ (Ehrsson, 2007) involves using real-time video from two cameras located behind the subject’s physical body, shown participant in a head-mounted display (HMD). The subject sees their chest being stroked by an experimenter with a small rod (Figure 12). The participant pairs the felt sensations with the observed movements. Interestingly, the rod is simply approaching the cameras, and it is only the approach of the rod observed in the cameras, synchronous with one’s felt sensation on their real chest, that elicits this out-of-body illusion and makes subjects feel that the rod approaching the cameras is directly causing the felt touch. This illusion involves the feeling of having an unseen body that is being touched in the location below the cameras, which is called the illusory body, as well as the experience of being located in that position (behind one’s real body), which is called illusory self-location. Asynchronous stimulation modulates this effect, weakening it quite significantly, and thus the stimuli must be synchronous for the effect to occur. Subjects rated how strongly they experienced themselves to be located at their veridical location and at the illusory location from 0 to 100, “I did not experience being located here at all” to “I had a very strong experience of being located here.” During an out-of-body illusion, Guterstam and Ehrsson (2013) report that subjects experience of being located at the in their real body was dramatically reduced by synchronous stimulation, while the experience of being located in the illusory location significantly increased.

It is useful to note here that the Temporo-Parietal Junction (TPJ) has been shown to activate during out-of-body experiences (Blanke, 2010). The TPJ has been identified as a key neural structure underlying awareness of self-other distinctions that aid emotion understanding and empathy (Decety, 2010). The TPJ is involved in integrating multisensory streams of information to form a unified, coherent sense of body and self (Tsakiris, Costantini, & Haggard, 2008). Inhibiting TPJ activation with transcranial magnetic stimulation (TMS) impairs subjects’ ability to mentally transform their body during OBE visualization tasks (Blanke et al., 2005). Mai et al. (2016) found that transcranial
direct current stimulation used to inhibit activation of the right TPJ (cathodal) decreased subjects’ accuracy on mental state attribution and cognitive empathy tasks. Thus, there may be important links between OBEs, perspective taking, and awareness of self-other distinctions, all involving the TPJ.

The Out-of-Body Illusion was shown to reduce fear of death after a VR simulation designed to replicate autoscopic phenomena (seeing one’s own body from above) reported in near-death experiences (Bourdin, Barberia, Oliva, & Slater, 2017). The OuterBody Experience Lab⁴ created in 2012 by Jason Wilson, is a gamified creative technology installation using aerial cameras with live-streamed video into HMDs. The cameras are placed in corners above the user, so the user sees their own body in space from a bird’s eye view. The user’s body appears like a video game character moving around. The user can observe their own body, third-personally and from above, as they move around a room and other people. In the game, users are tasked with retrieving various objects and moving them to specific locations, while cooperating with other users and racing against a clock. Successful navigation in the game requires understanding the movements of one’s body in relation to other people, floor marks, and objects in the room (Figure 13). Interestingly, users can adapt and engage in motoric team-based coordination throughout a room space, such as playing dodgeball. The game involves third-person matching of their seen body in the HMD to muscular and proprioceptive feedback from their real body, creating a new perspective on self-movement.

**The Full-Body Illusion**

In the full-body illusion (Leggenhager et al., 2007), participants see their own back projected in front of them in an HMD live video feed of cameras that are actually behind them, and again synchronous tactile stimulation with a rod to their observed back (in the HMD live video stream) and the felt sensation induces an out-of-body experience (Figure 14). The Experimenter then removes the HMD, blindfolds the subject, walks them around in the room, asks them to walk back to the place where their body had initially been. The researchers observed that subjects would walk closer to the illusory location of where their body had been projected to be in the HMD (proprioceptive drift). In a similar paradigm, researchers will show participants a simple architectural aerial line drawing of the room space, indicating the location of the cameras and equipment, and ask the participant to indicate where their body had been located within the space during the experiment with similar effects of proprioceptive drift towards the illusory body. Temporally and spatially congruent visual and somatic signals in egocentric reference frames cause a change in perceived self-location from the veridical location in the room to the location where the cameras were placed.

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⁴ [http://outerbody.org](http://outerbody.org)
BODY SWAP ILLUSIONS

In the ‘body swap illusion’ (Petkova & Ehrsson, 2008), participants experience a mannequin body as their own so that when the subject looks down they see a mannequin body being touched. This is accomplished by positioning two downward-facing cameras on the head of a mannequin body and streamed into the user’s HMD, such that the user looked down to see the mannequin torso. Petkova & Ehrsson (2008) then induced the illusion by applying synchronous touch to the mannequin’s torso and the subject’s real torso (Figure 15).

In a second experiment, a confederate wore head-mounted cameras with a live video streamed into an HMD worn by a subject to induce a similar effect. This qualifies as virtual alterity since it involves a body swap into the body of another real person. An experimenter applied synchronous VT stimulation to the confederate’s arm and the subject’s arm, inducing a body ownership illusion. Then researchers asked subjects to shake hands with the confederate, which in the body swap appears as though they are shaking their own hand (Figure 16). The user can see themselves third-personally from the point of view of the swapped-into body of the confederate, and yet the ownership illusion still persists. This study inspired designs for the The Machine to Be Another Classic Setup and Body Swap, which involves egocentric perspective sharing that could open new possibilities for being with another, impacting communication and empathy. Importantly, Petkova and Ehrsson’s experiment only involves swapping-into the body of another person, and is thus closer to the MBA classic setup, versus the mutual swap that the MBA body swap uses. Thus, I would align Petkova & Ehrsson’s experiment more as a body transfer illusion into the body of a real person than a full body swap.

Ekholm (2014) conducted a similar body swap experiment for his Master’s thesis, Meeting Myself from Another’s Point of View, in which two real people experience a body swap illusion and see from one another’s point of view (Figure 17). Ekholm used a stereoscopic camera setup to simulate stereoscopic vision, as well as binaural microphones to simulate an auditory perspectival swap rather than just a visual swap, which inspired protocols for Paint With Me. Both subjects wore Oculus Drift DK2 VR headsets with two small cameras mounted in front, and the HMCs from one subject were live-streamed into a video seen in the VR headset worn by their partner (thus it is a full swap versus a one-way body transfer). Binaural microphone input was also swapped into the

Figure 15. The Body Swap Illusion by Petkova & Ehrsson using VT stimulation to transfer into a mannequin body.

Figure 16. The handshake task used in Petkova & Ehrsson’s (2008) second body swap illusion experiment, swapping-into the body of another real human subject and seeing oneself from that view.

Figure 17. Ekholm’s (2014) body swap setup where two people see and hear from one another’s point of view.
binaural earphones worn by their partner. Thus, both subjects see and hear from one another’s embodied, first-person point of view (such that when they look down they see the torso of the other person), and also see themselves from the other person’s point of view. Extending Petkova & Ehrsson’s (2008) findings, subjects still experienced illusory self-location in the body of the other person even though they could see their own real, physical body in full view. Specifically, in a handshake task, subjects can see their own arm, hand, torso, and face (partially obstructed by the HMD), and yet still have a body transfer effect of ‘feeling from’ the arm, hand, and body of the other person. Thus, even seeing one’s own real body does not seem to interfere with the strong effects of cross-modal synchronous stimulation in inducing a sense of being outside one’s own body. Interestingly, Ekholm (2014) found that the strength of the body ownership illusion was decreased in subjects who had a regular body-awareness practice, such as dancers, athletes, and meditators.

Jazbec and colleagues (2016) conducted a body-swap experiment with an anthropomorphically and aesthetically realistic humanoid robot, Geminoid HI-2 (Figure 18), at Hiroshi Ishiguro Laboratories. This study investigated the relationship between agency and sense of ownership towards a different body. The team used stereoscopic cameras live streamed into an HMD. Jazbec’s team replicated the Phase 1 and Phase 2 protocols from the MBA Body Swap. Initially, a black curtain separates the subject’s body from the robot body. In Phase 2, subjects were instructed to look around and look at their newly adopted robot body. Two experimenters choreographed synchronous and spatially congruent touch stimuli on the Geminoid HI-2 robot body and the subject’s body. In Phase 2, the experimenters removed the curtain and moved the subject closer to the robot so that the user can see themselves from the point of view of the robot. Subjects are asked to touch their own real body through the Genimoid HI-2 robot. Experimenters controlled the Geminoid HI-2 through a motor synchronization task such that the robot would mirror and imitate the movements of the human subject (VM synchrony).

Participants reported that they felt like they were inhabiting two bodies simultaneously, confusing their sense of whether they were the one being touched or the one doing the touching within the illusion. Jazbec et al. (2017) conclude that as opposed to compromising subjects’ body awareness (of their real body), which Guterstam and Ehrsson argue for as a ‘disownership’ effect of body ownership illusions, the body swap illusion temporarily disorients subjects’ self-recognition. Jazbec et al. (2016) also employed a pointing paradigm to measure perceived self-location by asking subjects to point to where they were, and found that subjects would point towards the robot, towards the point of view they had in the IVE setup, rather than to their seen real body.

2.5 Bodily Illusions in VR

While synchronous visuotactile (VT) stimulation can induce a body ownership illusion (BOI), other factors have been shown to induce the illusion of ownership towards a surrogate body part. In addition to touch, sense of agency during active, voluntary movement also constitute sources of body awareness (Tsakaris & Haggard, 2005). Combinations of sensory input from vision, touch, proprioception, and motor control impact body perceptions (Klackert & Ehrsson, 2012). Researchers
have found that synchronous visuo-proprioceptive correlations through passive and active movements can also induce the illusion of ownership towards a surrogate body part (Dummer et al., 2009; Tsakaris, Prabhu, & Haggard, 2006). For example, Sanchez-Vives et al. (2010) evoked the illusion of ownership of a virtual hand through synchrony between movements of the subject’s real and virtual hand, termed visuomotor (VM) synchrony. This is important for creating bodily illusions in VR.

2.5.1 **Relative Importance of VT and VM Synchrony in Producing a BOI**

Kokkinara and Slater (2014) conducted an experimental study to test the relative importance of VT and VM synchrony on evoking a BOI. They used VR to integrate visual, motor, and tactile feedback in a paradigm where subjects wore a HMD showing a virtual avatar body from a first-person perspective (1PP) such that the subject’s visual field of their own body was replaced by the avatar body. The experimenter used a wand with a foam ball attached to deliver tactile stimulation by tapping the subject’s real legs. The movements of the wand were tracked and rendered in the virtual environment, represented simply as a red ball. The participant’s feet were tracked with OptiTrack infrared cameras so that the virtual legs would move congruently with the participant’s real legs. Participants sat in a chair and either moved their leg (VM stimulation) or had it tapped or stroked by an experimenter (VT stimulation). For the VM stimulation, participants were instructed to trace a line of different shapes with their heel. The experimenters used synchronous and asynchronous conditions for VM stimulation with motion tracking in the synchronous condition and a pre-recorded virtual leg animation in the asynchronous condition. In order to test for moments of breaking from the illusion during stimulation, the experimenters employed an intermittent measure whereby participants verbally reported “Now” when the body ownership illusion was lost, broken, or interrupted. This allowed experimenters to gain a deeper sense of the temporal scale and subjective experience of the illusion during stimulation, rather than just after stimulation. As such, the researchers also attempted to study factors that contribute to and disrupt BOIs.

There were four experimental conditions: VM and VT both synchronous, VM and VT both asynchronous, VM synchronous with asynchronous VT, and VT synchronous with asynchronous VM. The researchers found that VM stimulation had a greater determining role than VT stimulation in generating the body ownership illusion. Specifically, the subjects in the VM synchronous and VT asynchronous condition still experienced a BOI, but when VM was not synchronous the illusion rapidly broke down. Thus, the researchers conclude that “...asynchronous VT may be discounted when synchronous VM cues are provided.” (p. 56) These findings are consistent with an earlier study by Kilteni et al. (2012), where subjects’ movements were congruent with a virtual hand, and the BOI was not compromised when the subject’s real hand grasped an object not rendered in the virtual world/hand. Thus, incongruent and asynchronous tactile stimulation appears to not have as strong of a constituting role in BOIs when there is synchronous VM stimulation. Kokkinara and Slater’s (2014) study on the relative importance of VT and VM synchrony on BOIs indicates that the sensorimotor
correspondences may have a more important role in contributing to the effects in embodied simulation studies than sensory correspondences.

2.5.2 Agency Illusions

Baileya, Bailenson, and Casasanto (2016) write that in motion-tracked VEs, users are able to map sensorimotor contingencies and body perceptions to an avatar through two means: 1) afferent or sensory signal correspondences, or 2) sensorimotor correspondences between the physical body and the virtual body. Sensorimotor correspondences occur when participants see virtual or artificial body movements that are synchronous with the user's own real physical body (VM synchrony). Sensorimotor contingency matching to a virtual or artificial body creates a new effect, called an Agency Illusion, which is measured through questions asking subjects to rate the extent to which they felt like the movements of the fake body or body part were their own, and the extent to which they felt they could control the movements of the fake body or body part (Casper et al, 2015). Agency illusions occur through active, voluntary movements that allow participants to control an artificial or avatar body. Sense of Agency (SoA) is the feeling of authorship for self-generated movements and the external events they cause (de Vignemont & Fourneret, 2004). Kalckert and Ehrsson (2012) found that participants who had passive control over artificial limb movement during a RHI experienced ownership but not agency, but when they had active control during the RHI they felt both ownership and agency. This is important because The Machine to Be Another and Paint With Me find an agency illusion in the absence of a BOI, which is a unique finding in the literature.

2.6 BOIs and Empathy

BOI experimental manipulations are used in empathy research because these illusions can alter perceived similarity to others, which has been shown to increase social influence and empathy-related responses such as decreasing out-group biases, specifically racial biases and stereotypes. VR interventions using BOIs have shown efficacy in promoting empathy-related responses such as altruism (Rosenberg, Baughmen, & Bailenson, 2013), self-compassion (Falconer et al., 2016), and reduction of implicit biases (Peck et al., 2013). BOI may increase self-other merging, a conceptual re-framing whereby the empathizer’s self-image incorporates the other such that the empathizer and the person in need (target) are seen as psychologically “one” (Aron & Aron, 1986; Batson, 2011). Specifically, this could be because we see aspects of ourselves in the other (Cialdini, Brown, Lewis, Luic, & Neuberg, 1997; Maner et al., 2002). Evidence suggests that perceiving another as like oneself or as having a shared group identity increases the likelihood of emotionally empathizing with another and willingness to help (Krebs, 1975; Stotland, 1969). Self-other merging could also occur because we see ourselves and the person who is in need as interchangeable exemplars in a common group identity (Dawes, van de Kragt, & Orbell, 1988; Turner, 1987). This section explores the link between BOIs and these empathy-related responses to analyze the mechanisms that promote these effects.

Farmer, Tajadura-Jiménez, & Tsakaris (2012) induced a RHI with white participants on a fake hand representing a different racial group (a black rubber hand), in addition to a light-skinned rubber hand. They found that participants experience the RHI over a fake hand that appears to belong to a different racial group. Moreover, existing racial biases impacted the self-reported strength of the illusion of ownership over a black rubber hand. The researchers also investigated whether the RHI would be enough to alter higher-level social perceptions and change implicit attitudes. They found that the strength of the RHI was directly correlated with decreases in implicit racial biases, as measured by the Implicit Association Task (IAT; Greenwald, McGhee, & Schwartz, 1998). The IAT is a word-association task designed to elicit unconscious stereotypes and prejudices. Stereotypes are a tool that allow us to rapidly categorize others, and they may modulate our cognitive and affective
reactivity to others. Racial differences are one of the most ubiquitous stereotypes. Farmer et al. (2012) suggest that BOIs may have a role in "overriding" ingroup/outgroup distinctions based on skin color. Thus, multisensory integration causes participants to experience a different skin-colored body part as one’s own, and this increases a sense of similarity between oneself and the racial outgroup and decreases implicit biases.

Racial biases have been shown to interfere with aspects of embodied social cognition, such as sensorimotor activation, shared bodily representations, and mirror neuron activation in areas underpinning simulation of and affective responses to another’s pain (Xu et al., 2009; Avenanti, et al., 2010). Xu, Zuo, Wang, & Han (2009) used fMRI to study neural responses while the subjects observed racial in-group and out-group members in pain, and found heightened anterior cingulate cortex (part of the ‘pain matrix’) activation with in-group pain stimuli but not with out-group pain. Similarly, Avenanti, Sirigu, & Aglioti (2010) observed significantly lower neural activation of affective and motor responses when participants observed a member of a racial outgroup experiencing pain, as compared to observing a member of the participant’s racial in-group experiencing pain. Moreover, subjects responded less to racial out-group pain than to pain on an unfamiliar purple hand (with highest response to racial in-group). This decrease in neural activation is important because it involves aspects of the Mirror Neuron (MN) System indicating self-other overlap in bodily representations (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Shared representations involve overlapping areas of neural activation between one’s own neural emotional and body representations with the neural activations that occur when perceiving or imagining the bodily and emotional states of another person. Thomas Fuchs (2016) summarizes shared representations and simulation accounts of empathy succinctly: “The brain simulates the expressions and actions that occur in the other’s body through the virtual activation of our own bodily states; it can then, in turn, project these quasi-experiences onto the other as if we were placed in his shoes.” (p. 155) Avenanti et al. (2010) found that decreased activation of shared neural representations was correlated with subjects’ implicit racial biases; that is, the more biased a subject is to a racial outgroup, the greater the decrease in neural resonance and shared representations with that racial outgroup. This means that social categorization based on racial group membership modulates the capacities of our social brain, specifically our ability to share someone else’s emotions and pain.

The key reason that these BOI experiments have a role in empathy research is as follows. Activation of shared representations is modulated by the perceiver’s identification with the observed person(s), which is based on their implicit appraisals based on similarity, familiarity, and social closeness (de Vignemont, 2006; Hein & Singer, 2008). While many subjects report low out-group and racial biases on explicit self-report measures, implicit attitude measures like the IAT still indicate negative biases and stereotypes. Empathy research has shown that there is a lack of shared representations observed with out-group others, specifically those with racial biases, which has been described as the ‘empathy gap’ (Gutsell & Inzlicht, 2011). This has been characterized as an inability to bridge self-representations to other-representations for neural activations and body representations. The claim is that BOIs help close this empathy gap by causing the subject to partially overlap body representations for oneself with those of an out-group member, which extends into greater affiliation with and positive social attitudes towards out-groups. Specifically, BOIs compensate for the lack of shared representations with out-group members that substitute for the shared representation mechanisms activated in response to in-group members with whom one identifies. In an opinion piece entitled “Changing Bodies, Changing Minds” summarizing findings from inducing full-body ownership illusions in VR, Maister, Slater, Sanchez-Vives, and Tsakiris (2015) write, “These shared body representations are thought to form the fundamental basis of empathy and our understanding of others’ emotions and actions.” (p. 6) BOIs are thus seen as a tool to experimentally increase sharing of body representations to impact ingroup/outgroup categorizations. This theory of empathy is the motivation for the design in avatar-based embodied simulation studies, which I describe in the next section.
Virtual Alterity projects attempt to bridge the empathy gap through relational, interactive interfaces that develop an understanding of another through participatory engagement with aspects of another person’s embodied, first-person perspective and subjective experiences. This chapter proposes virtual alterity systems as an alternative to avatar embodiment studies. First, I discuss studies using avatar embodiment to impact negative biases and increase positive attitudes towards others.

2.7 Avatar Embodiment and Empathy

Bodily illusions indicate that under specific multisensory conditions, humans can experience artificial body parts, fake bodies, avatar bodies or virtual bodies as one’s own body parts or body. The BOI is one of the major paradigms used in VR research. Immersive VR produces body and perceptual illusions by presenting virtual information from a first-person visual perspective while users embody an avatar body. This alters the user’s perspective of their own body and self-location. Rather than looking down and seeing their own real body, in VR the participant looks down and sees a virtual body (torso, arms, legs, feet). Evidence indicates that VR technologies produce a strong effect of ownership over a virtual body (Lenggenhager, Tadi, Metzinger, & Blanke, 2007; Petkova & Ehrsson, 2008). The key to full-body ownership illusions in VR is the substitution of a virtual body seen through a first-person perspective, such that the virtual body is aligned with the subject’s visuospatial first-person perspective of their real body (Petkova, Khoshnevis, & Ehrsson, 2011). Thus, VR can be used to induce embodiment and a full body ownership illusion (FBOI) by creating multi-sensory stimuli combining first-person perspective (1PP) with visuomotor (VM) and visuotactile (VT) synchronicity (Maselli et al., 2013).

An avatar is a 3-Dimensional representation of a person within a virtual environment that configures the ways that the user sees themselves and the way others see them (Blascovich and Bailenson, 2011). An avatar might not correspond at all to a user’s visible, audible, and behavioral characteristics, but research indicates that users identify more strongly and experience a greater sense of presence when their avatar looks more like them (LaVelle, 2016). Avatar embodiment studies are conducted in labs that have motion-tracking body suits to track users’ movements in real time, and render these movements onto the avatar body. This creates a new effect where the user experiences a sense of agency over the avatar body. Slater claims that avatar-based embodied simulations in VR can impact the automatic associations that people make about one another based on their bodies, and thus reduce tensions between different groups of people (as quoted in Bennington-Castro, 2013). This instantiation of empathy is based on perceived similarity between self and other, whereas virtual alterity projects emphasize perceived self-other distinctions within an experience of merging. The evidence that avatar embodiment increases empathic outcomes is inconclusive, and the literature suggests many confabulating variables. Here I review virtual embodiment studies that indicate both positive and negative effects on empathy.

Peck et al. (2013) used an embodiment simulation involving three features which have become standards in avatar embodiment studies: 1) 1PP, meaning that the virtual body aligns with and substitutes the user’s real body, 2) a virtual mirror that geometrically matches the user’s real body and shows the avatar body in full view, and 3) a motion-capture bodysuit that tracks and renders the user’s movements synchronously onto the virtual avatar in VR. They extended the findings from RHI with black rubber hands into VR to measure BOI over a black-body avatar using the avatar embodiment framework, and measured implicit racial bias changes after avatar embodiment. Participants completed an initial Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) three days before avatar embodiment. The IAT involved rapidly associating faces of different racial groups with positive or negative words, which for racial bias involves longer reaction times for positive words paired to racial out-groups than in-groups, and fewer positive word associations with racial out-groups (Greenwald, Nosek, & Banaji, 2003).
After the initial IAT measure, subjects returned to the lab and were divided into four different conditions of avatar embodiment: light-skin, dark-skin, non-embodied dark-skin (seeing dark-skin avatar moving asynchronously in the mirror with no 1PP virtual body), alien-skin (purple skin tone avatar body). In the embodiment phase, participants were instructed to look around the environment, look in the mirror, and explore and move their virtual body. This induced a BOI across all virtual embodiment conditions, and users who experienced a BOI over the black avatars had decreased racial biases. Virtual embodiment in the white and alien-skin avatar bodies did not produce significantly strong racial bias changes, isolating the effect to dark-skin virtual embodiment. The non-embodied, asynchronous movement dark-skin avatar embodiment condition produced a much lower BOI, indicating the effect of the illusion to reduce racial prejudices.

However, in a similar study, Groom, Bailenson, and Nass (2009) divided subjects into either in a black or white avatar, and found that those who embodied a black avatar had greater racial ingroup preferences in implicit attitudes after avatar embodiment. Thus, manipulations of self-identity through different forms of an avatar body do not necessarily reduce negative racial biases. It is possible that avatar embodiment can also activate stereotypes that aggravate negative attitudes for individuals who have low commitment to the racial group of the avatar (Ellemers, Spears, & Doosje, 2002). Perceived threat may be a factor that impacts intergroup bias (the tendency to prefer one’s ingroup to an out-group). In Groom and colleagues (2009) setup, subjects were in a high-stress interview, and thus, embodying an avatar of a systematically disadvantaged out-group may increase anxiety and indicate a self-threat to their own interview success.

Walking around in the avatar of an elderly person versus the avatar of a younger person contributed to greater stereotype reductions towards the elderly (Yee & Bailenson, 2006). Oh, Bailenson, Weisz, & Zaki (2016) compared the effects of reduced prejudice towards elderly (ageism) between mental simulation (traditional perspective taking) using a first-person, text-based description compared to virtually embodying an elderly person in VR. The authors found that the intervention of embodying an avatar of an elderly person in VR increased participant’s self-other merging and desire to communicate with the elderly, and that these positive increases were greater in the VR condition than the mental simulation condition. Prior to the intervention, subjects were split into two groups to read and write a summary of short articles that indicated either a high or low intergroup threat: “Elderly Pose Immediate Threat to Young Americans” (high threat) or “America Prepared for Changing Demographics” (low threat). Interestingly, subjects in the high-threat condition had greater self-other merging and intention to communicate than subjects in the low-threat condition. The authors suggest that embodying an elderly person after expressing negative attitudes may have caused participants in the high-threat condition to feel guiltier about any previous negative attitudes, and these feelings of guilt may cause people to show more empathy.

In this study, subjects in the VR condition were given the following instructions: “For the next minute, look closely at your reflection in the mirror. This is what you look like to others in the
virtual world. Imagine a day in the life of this individual, looking at the world through her/his eyes and walking through the world in her/his shoes.” (Oh et al., 2016, p. 401-2)

These instructions are limiting because no information is provided about the specific elderly person the subjects virtually embody, which Gelbach and colleagues (2015) found to be an important variable to facilitate perspective taking. Gelbach et al. (2015) write, “One could argue that, when individuals are instructed to take the perspective of someone else, but given little or no information about who this person is, there is no actual perspective to be taken.” (p. 21) This is one of my biggest concerns with avatar embodiment studies, and one of the main reasons I argue for combing virtual embodiment with perspective-taking VR for optimal efficacy in facilitating empathic outcomes. Batson et al. (1997) found that imagining how you would feel in another person’s situation (self-focused perspective taking) has differential effects than imagining how the target person feels (other-focused perspective taking). This is important because in Oh et al.’s (2016) study, subjects are given context about the group (elderly persons) in the reading and writing task, but not about the specific individual who they virtually embody or mentally imagine.

### 2.8 LIMITATIONS OF AVATAR EMBODIMENT FOR EMPATHY RESEARCH

While avatar embodiment studies offer a valuable starting point for empathic VR, they have some limitations. First, the studies conceive of empathy by way of identification, perceived similarity, and affiliation, but this is a very narrow way of understanding empathy that does not involve sharing or recognizing another as distinct from oneself. Second, the setups do not allow the user to engage in affective or cognitive perspective taking to understand the ways that another person would experience a situation, but instead only allow users to reflect on their own experience and as such are very self-oriented versus other-oriented. Lastly, the setups only explore attitude changes, but it is unclear whether this could impact motivational changes or behavior changes, specifically in a real-world context.

Slater et al. (2010) claim that simply perceiving a virtual body from a first-person perspective with VM synchrony is sufficient to create BOIs, and that BOIs foster a sense of identification through greater self-other overlap with the out-group that the avatar represents. However, I question whether avatar embodiment setups encourage an awareness of the other as other. This is the motivation for the design and research in virtual alterity projects. Rather than experiencing oneself as another, virtual alterity paradigms facilitate a richer experience of another by augmenting our access to aspects of the minded being of another person. While I agree with Slater et al. (2010) that the first-person perspective is valuable for convincing and effective illusions in VEs, I do not consider BOIs necessary to change self-other overlap. For example, Ahn et al. (2015) successfully promoted helping behavior in a perspective-taking VR that did not involve a BOI or an avatar body. In this study, users engage in perspective-taking to by either mentally imagining a task space as it would appear to a colorblind person in a written script or in a first-person Immersive Virtual Environment (IVE) that displayed the task space the way that it would be seen by the way a colorblind person. Thus, rather than just embodying an avatar, perspective-taking VEs allow users to see the world as the other would see it. Afterwards, subjects in the IVE condition were more willing to stay after and help the colorblind confederate and spent more time helping than subjects in the text-only mentalizing condition. Moreover, Ahn et al. (2015) used the Self-Other Merging scale and observed greater self-other overlap in the IVE condition, indicating that BOIs are not essential for increasing self-other overlap.

I argue that identification is not the most effective model for empathy. While avatar embodiment studies may foster a sense of identification with others towards greater inclusivity, perspective taking VEs can help subjects understand the meaningful differences in another person’s experience of a situation so that the subjects can know how to help the other, and increase empathic
concern. Thus, beyond fostering a sense of identification with the other, perspective-taking VEs foster a recognition of self-other distinctions. Virtual alterity systems combine PT and 1PP virtual embodiment to maximize the effects of seeing as another while also moving with another in a coordinated and synchronized manner.

Maister et al. (2015) write that shared body representations are the basis of empathy. While shared representations may be an enabling condition for certain empathic processes, they are not sufficient to produce mature empathy. Shared representations are based in perceived similarity and promote inclusivity, but shared representations are not sufficient to produce other-oriented empathic concern. This is one of the limitations of altering body representations as an intervention for increasing empathy. To demonstrate that shared representations are not sufficient to produce other-oriented empathic concern, I cite Becks, Coan, and Hasslmo’s (2013) study on physiological linkage and emotional attunement that does not indicate increased empathic concern. Becks et al. (2013) conducted a functional magnetic resonance imaging (fMRI) study with married couples investigating neural regions underlying anticipatory anxiety to a shock threat as mediated by hand-holding with a stranger (experimenter), versus a close other (friend or spouse), or a control with no hand holding. The experiment involved shocks delivered randomly to oneself (the subject), a stranger, or a close other. They found that the neural response to threat to oneself and threat to a friend were very similar, indicating that close identification with a friend causes people to treat the friend as if they were the self (inclusion of the other into the self-model). This identification effect does not occur for strangers.

Beck et al. (2013) propose that the brain may encode close others as part of the self, and that there is a blurring of self and other. Moreover, the effect of neural resonance was modulated by perceived similarity to the stranger. While subjects do have a neural response to stranger pain, this response is not like the self unless subjects assume that the stranger is a lot like them. This effect seems to indicate a benefit to manipulating perceived self-other similarity to allow out-group others to be perceived more like kin. However, assuming that another feels the same pain as oneself in response to the same stimuli may interfere with the appropriate empathetic response. This framework assumes, “I felt this way in response to this situation, and because you are similar to me, you must feel the same.” That is, rather than, “I feel your pain”, this setup elicits, “I assume your pain feels the same as mine.” This involves a collapse of the other’s emotions into one’s own. One important feature of mature empathy is recognizing that another person may feel differently than you do in response to the same or similar situation. Thus, shared representations are not sufficient to produce other-oriented empathy and prosocial responses.

BOI research focuses on the malleability of factors that normally block empathy, starting with an empathic deficit based on intergroup biases. Further research could explore increasing empathy beyond this baseline to foster greater care and concern for others rather than just reducing biases. In avatar and BOI studies, implicit attitudes towards out-group others are modified to match positive self-appraisal and in-group attitudes. However, the problem with this design is that if these implicit attitudes are transformed, this may not impact real-world motivations and behaviors towards out-groups. Subjects may not be conscious of their implicit attitude changes (unless there is elaborate debriefing), in which case the individual cannot knowingly incorporate this attitude transformation into their social interactions and how they encounter out-group others.

Research on the formation of stereotypes has shown that people adjust their perception of in-groups and out-groups based on their personal experiences with individual members of those groups (Weber and Crocker, 1983; Johnston and Hewstone, 1992). Avatar embodiment involves an experience of self-identification with the out-group other, experiencing the other as transposed onto the self, rather than an experience of being with the out-group other. While avatar embodiment experiences may be personally meaningful and involve strong emotions, the self-other distinction is not established. As such, avatar embodiment setups involve a transformed experience of the self but not necessarily a transformed experience of the out-group other. Specifically, there is no real other to
understand or with whom to empathize. The avatar is not a real other, but merely a computer graphic representation.

Corona (2013) conducted studies using a black rubber hand that diverge from these findings. She induced a RHI over either a black or white fake hand, and explored its impact on subsequent implicit mimicry of in-group and out-group facial expressions of happiness and sadness. In her studies, empathic responses towards other-race individuals was not impacted by the incorporation of out-group bodily features into the subject’s own body image. After the RHI, she instructed subjects to first passively attend to stimulus materials (emotional faces), and then after a certain number of trials subjects were asked to imagine what the target was feeling. Expressions of happiness were imitated during both passive attention and active imagination instructions, but sad expressions were only imitated with active imagination instructions. Skin conductance measures indicated a racial in-group bias during the passive condition (with greater conductance when witnessing emotional pain of in-group faces) that disappeared when the instructions changed to trigger reflective processing and perspective-taking. These findings indicate that research designed to combat racial biases could benefit by stimulating active perspective taking and reflectively processing what another might be feeling. This is not explicitly a component of avatar embodiment studies, and virtual alterity projects aim to evoke this active reflection on another’s affective state during virtual embodiment.

Lastly, it’s useful to note that there is a very practical limitation to avatar embodiment research. As Leyer, Linkenauger, Bulthoff, & Moheler, (2015) explain, this technology “requires expensive motion capture equipment, highly refined software, and sophisticated 3D models of the human body with a rigged skeleton, all of which require a great deal of money, time, and specialized expertise.” (p. 12) While virtual alterity systems do not entirely avoid these high costs and fancy equipment, it is generally simpler to work with a video-based environment in a mixed reality setup using real physical objects and real human subjects than to operate with advanced motion-tracking and capture simulated (computer-generated) virtual worlds. When I mentioned this to Domna Bonakou, a Post-Doctoral researcher at EVENT Lab Barcelona, she mentioned that the reason these setups are used over potentially simpler video-based setups with real people is that they offer high experimental controllability for isolating variables. Prerecorded video footage and discretely choreographed stimuli contribute to greater experimental control in virtual alterity studies.

Avatar embodiment in VR may be an important first step to combat deep-rooted biases and rapid judgments about others that are at the root of stereotype and prejudice formation. But because these projects do not involve another real person to learn from and interact with, the design limits the possible outcomes for other-directed, prosocial, altruistic empathy. Users may over-identify with the other, assuming that they know more about the other’s experience than they actually do, specifically by assuming that others’ experiences are the same as their own affective or cognitive responses to stimuli within the avatar embodiment. Moreover, these experiences could trigger empathic over-arousal, a state in which a person becomes so personally affected by another’s distress that their ability to care for the other gets occluded by their need to alleviate their own distress. Personal distress and identification are orthogonal to empathic concern, and identified as factors that can interfere with empathic concern and compassion. That is, if I assume that your experience is the same as mine, I may not react appropriately to your distress. This begs the question: How can researchers use VR to increase inclusivity of out-group others while maintaining the self-other distinction? This is a question that virtual alterity projects attempt to resolve.

### 2.9 What Makes Virtual Alterity Projects Different

This section presents main points that distinguish virtual alterity projects from avatar embodiment studies. I suggest that virtual alterity systems offer an important contribution to VR research pertaining to empathy by operating under a different model for empathy that is other-focused and takes the psychological experience of a specific real person as the target for empathy.
2.9.1 Other-Oriented Perspective Taking and Empathy

I distinguish between identification with another and the recognizing another as separate but similar subjective being. This is central for my positing of virtual alterity systems as uniquely situated to facilitate empathy conceived as other-directed perspective taking and compassion. I argue that identification may confound recognizing the other as other, thus limiting the scale and scope of empathic responses, specifically in the way of compassion. Compassion involves care for the wellbeing of the other, versus egoistic motivations or empathic distress (see Chapter 1). Avatar embodiment studies evoke identification and perceived similarity to foster greater inclusivity. By contrast, virtual alterity systems evoke recognition of the alterity of another and sharing of bodily and agentive experiences to foster positive regard for the other and compassion.

In avatar studies, much of the emphasis for the user is on my experience in this new body where I experience myself differently. Therefore, avatar-based interfaces may not contribute much to understanding empathy as a quintessentially other-directed emotion or intentional stance. This is inconsistent with findings on the importance of the self-other distinction in empathy and the metacognitive processes involved in recognizing that another's experiences might be different from your own, and even from your inferences about their experiences. Virtual alterity systems focus on how people can use technology for deeper acquaintance with another's experience. Avatar studies cultivate a relationship to an avatar who is representing a real person abstractly in a computer-simulated world. The user is not directed towards the avatar as another, but instead controls the avatar-other like a puppeteer exploring his or her own actions and embodiment. Rather than cultivating self-other merging through identification and perceived similarity with the other, virtual alterity systems foster self-other merging through shared agency that spontaneously emerges in interfaces designed to focus attention on another person’s experiences.

2.9.2 Understanding Other’s Experience as Different from One’s Own Experience

The goal of virtual alterity systems is to drive users to be curious about how another’s emotions, thoughts, reactions, and expressive acts may be different from one’s own, rather than merely perceiving the other as similar to oneself. Specifically, whereas participants in avatar embodiment studies are situated to feel like they are the avatar body, participants in virtual alterity studies are situated to feel like they are gaining access to a part of someone else’s experience that is importantly not their own. These systems allow users to interact with one another from within the other’s first-person perspective, opening a new structure for social interaction and interpersonal engagement (see Bailenson et al., 2008). Virtual alterity systems utilize augmented interfaces to create inter-identity technologies, which Lindgren and Pia (2012) defines as hybrid spaces that combine one person’s experience with that of another person.

2.9.3 Merging Based on Interconnection Versus Identification

The Inclusion of the Other into the Self Model (IOS; Aron, Aron, & Smollen, 1992) stipulates the self as a template for understanding others. This model is used to measure a construct called self-other merging (SOM), which is a sense of feeling psychologically “at one with” another person. However, I think the IOS is wrongly named, and that much of the research relying on it is based on identification rather than merging. Identification and “including the other into the self” involves perceiving the other as part of one’s affiliated in-group or like oneself, implicating an egocentricity bias. While identification may be one feature that can contribute to SOM, it is limited, as it posits that we only come to experience SOM with others with whom we identify and perceive as like ourselves. I propose a different model for self-other merging based on interconnectedness versus identification. Interconnectedness involves recognition of another person as part of a shared human experience that is broader than both self and other, whereas identification merely posits the other as like oneself. I argue that SOM instead involves an expansion of one’s egocentricity to include the other, rather than
collapsing the other into the self-model. More specifically, I argue that in mature empathy self-other merging emerges in parallel to self-other differentiation such that one can experience a sense of increased interconnection amidst an increased awareness of the other as a subject of his or her own life experiences with unique history and context. This is what virtual alterity projects aim to accomplish. Thus, I claim that IOS and avatar embodiment studies over-emphasize the role of perceived similarity and identification in empathy, while missing important features of SOM in the sense of interconnectedness, ego suppression, and the expansion of the sense of self.

2.9.4 RELATIONAL EMPATHY: BEING-WITH VERSUS BEING-AS ANOTHER

Rather than self-other overlap through modifying shared body representations to induce merging, I propose self-other merging through relational, other-directed empathy. Virtual alterity combines embodied simulations with perspective-taking VEs that focus on how someone perceives something rather than just embodying the other. Perspective-taking in virtual alterity involves cognitive, affective, and embodied components. Virtual alterity systems involve a transmission of sensory features of experience within a specific task through multi-modal interactions, embodied perspectives, and narratives. As such, virtual alterity facilitates an emotionally meaningful experience between two or more people. Virtual alterity setups allow a unique egocentric perspective sharing, which could open new possibilities for sense of being-with another, impacting communication and empathy.

2.9.5 SHARING VERSUS OWNING

Virtual alterity systems foster self-other merging through shared agency illusions, rather than BOIs. Shared agency illusions elicit reflection on pre-reflective, automatic, egocentric processes towards a recognition of the interconnectivity between self and other. In virtual alterity studies, users report feeling brought into deeper aspects of another person’s first-person perspective, normally private and contained only for the individual for-themselves, versus for-others or with-others. while interacting with another from within aspects of the other’s first-person perspective. This allows users to share an embodied, first-person perspectival space rather than owning a new body representing another person. Subjects do not experience a very strong ownership illusion, but instead report a strong agency illusion. The BeAnother Lab (2017) team categorize this agency illusion as a shared agency illusion, which involves a sense of fluidity and moving with another versus moving as another. That is, the subject in virtual alterity studies does not experience a sense of authorship over actions in the way that avatar embodiment studies measure agency. Instead, users report that they lose sense of whether they are initiating or following movements during an imitation procedure while virtually embodied as the other. Thus, the self-other relationship is transformed in a way that focuses on a novel shared experience with the other.

CONCLUDING REMARKS

Embodied simulations allow users to inhabit an avatar body or the body of another real person. Embodying an avatar can produce attitudinal changes based on experiencing an avatar body of an out-group member it as though it were one’s own body. Body ownership illusions have been used as a paradigm to disrupt the unity of bodily self-consciousness, and to demonstrate the malleability of shared representations with out-group others with whom shared representations may be decreased. Inhabiting an avatar body from a 1PP has been an effective model for inducing a body ownership illusion and decreasing implicit biases. Agency illusions are also a feature of virtual embodiment, and avatar embodiment studies have not yet fully explicated the role of agency illusions
in transforming representations of and attitudes towards self and other. While virtual alterity projects *The Machine to Be Another* and *Paint With Me* both use the 1PP and VM synchrony with some VT synchrony, subjects do not report experiencing a BOI. Instead, they report experiencing a unique agency illusion. Rather than just embodying an avatar representing another person, perspective-taking VEs dissect various modes of first-person experience to facilitate a multi-sensory simulation of another person’s experience. This may have a more significant role in helping behavior, as suggested by Ahn et al.’s (2015) study. In the next chapter, I evaluate virtual alterity systems as another alternative for facilitating empathic processes and outcomes. The role of agency illusions in SOM and empathy has gained little attention, but as a feature of VEs agency illusions may be useful to offer a new model for how VEs can facilitate empathy. Virtual alterity studies disrupt aspects of egocentric experience through agency illusions while subjects also report a heightened awareness of another person, and this may have a role in empathy.
Chapter 3: Virtual Alterity Systems

3.1 INTRODUCING VIRTUAL ALTERITY

Virtual alterity is a term that I use in this thesis to classify a series of VR research and design projects that involve human-human interactions augmented by virtual interfaces simulating the modes of sensory, bodily, perceptual, affective and cognitive experiences as lived by another person and while engaging in a task together with that person. Virtual alterity allows two people to see, hear, and feel from the same physical, embodied perspective simultaneously while moving synchronously within this shared perspectival space. Virtual alterity projects combine elements from embodied simulations and perspective-taking interfaces in VR. Users virtually embody another real person and see through the lens of another’s perspective. Questions important for virtual alterity projects are how virtual environments can be optimally designed to simulate the structures of first-person experiences, how VEs can augment our access to one another’s minded and embodied being, and how VEs can open new interactive and communicative tools that go beyond face-to-face communication.

Virtual alterity systems explore the use of first-person perspective taking through VR technology as a tool to study and facilitate empathy. These systems involve aligning one person to the physical, embodied, and psychological experience of another specific real person. These systems allow users to learn about another’s modes of navigating a task or situation. Virtual alterity systems cultivate empathic engagement through coordinated activity, fostering a sense of being-with another, rather than inferring another’s mental or emotional states conceptually. Rather than relying exclusively on higher-order cognitive processes like mentalizing, mindreading, and symbolic processing, virtual alterity uses embodied perspective taking and multi-modal narratives to engage users in sensorimotor interactions with another real person. Virtual alterity involves new possibilities for social interaction, cognition, and empathy by providing new modes of access to one another’s experience and new structures for interaction. This overcomes communication and empathic barriers in attempting to orient to someone else’s relationship with a task, situation, or activity.

This chapter presents examples of systems that contain various key elements of virtual alterity systems. Then, I present preliminary findings from two virtual alterity setups, The Machine to Be Another Body Swap (BeAnother Lab, 2014; Bertrand et al., 2014) and Paint With Me (Gerry, 2017). These are both relational interfaces that involve seeing from another’s first-person embodiment while moving synchronously. Both setups allow users to share an outward, world-directedness with another real person. These studies extend findings from avatar embodiment studies by indicating that the Body Ownership Illusion is not necessary to produce a strong sense of embodiment, nor to promote empathic processes and outcomes.

3.2 HOW VIRTUAL ALTERITY SYSTEMS FACILITATE EMPATHY

Perspective-taking in VR essentially provides direct, external access to what the mind would otherwise have to mentally construct in imagining another person’s visuospatial or experiential perspective (Ahn et al, 2015). Developmental psychologists measure perspective taking as a capacity that develops with age through qualitatively distinct phases (Flavell, 2000; Selman, 1975). Batson et al. (1997) stipulate perspective-taking as a cognitive ability that involves high cognitive load. Chambers and Davis (2012) suggest that people need a convenient way to engage in perspective taking, and argue that the more easily people can imagine themselves in the place of others, the more
emotion they will have for others. Yee and Bailenson (2006) explain that perspective-taking in VR can allow users to actually take the place of someone else’s embodied perspective and be present in another’s perspective rather than just imagining it. Perspective-Taking VR can also provide tools to hone and train individuals’ cognitive PT abilities (Amichai-Hamburger, 2013). For example, Gehlbach et al. (2015) created increasingly challenging social perspective taking VR simulations with increasingly different individuals to progressively increase perspective-taking skills.

Guiding subjects to engage in cognitive and affective perspective taking is facilitated by VEs. Perspective-taking in VR can be an effective tool to facilitate empathy for stigmatized individuals, such as mentally ill or disabled. Kalyanaramen et al. (2010) found that a VR simulation of schizophrenia evoked more positive perceptions and greater empathic concern for schizophrenic individuals than a perspective-taking intervention involving listening to a narrative recording about schizophrenia and then writing about it. Similarly, Ahn et al. (2013) observed increased effects of SOM and helping behavior in VR compared to just reading about another person’s experience.

The Machine to Be Another (MBA) is a unique VE for fostering empathy because 1) it uses real human persons rather than avatars or virtual agents, 2) it involves a live camera feed from one person to another (synchronous and interactive), 3) it shares a very vulnerable part of our personhood, our first-personal egocentric bodily space, and 4) users experience face-to-face contact before and after the virtual interaction, and thus MBA serves as a complement to face-to-face interaction rather than a replacement. In the MBA body swap, individuals share aspects of their own egocentric, embodied experience with someone else while also gaining a deeper sense of someone else’s embodied experience. The MBA body swap functions as a form of mediated empathy, allowing users to feel closer to one another through the mediation of technology. The MBA body swap facilitates a new self-experience and a new other-experience. Thus, I define the MBA body swap as a form of self-and-other perspective taking and a relational interface.

Paint With Me (PWM) is a unique VE for fostering empathy because it allows a user to share and participate in another person’s creative, self-expressive process. PWM combines first-person visuospatial perspective taking with narrative and imitation. PWM functions as transformed social interaction, as it is a new way to interact with and learn from another real person involving superimposing one person’s embodied narrative on top of one’s own embodied perception.

## 3.3 Features of Virtual Alterity Systems

This section describes the key features of virtual alterity systems that distinguish these systems from other VR setups, including avatar embodiment. Virtual alterity projects extend previous work and aim to facilitate empathy by synchronizing with another’s bodily comportments and sensing aspects of another real person’s embodied and experiential perspective. The features of virtual alterity systems are 1) first-person point-of-view video, 2) motion tracking and sharing bodily comportments, 3) experiential perspective taking, and 4) transformed social interaction. Few projects combine these elements, but each element suggests ways that VR can be used to enhance our understanding of another person’s first-person experience. Thus, this section is descriptive of current projects and directive for future projects to increasingly combine these elements.
3.3.1 FIRST-PERSON POINT-OF-VIEW: SEEING WHAT ANOTHER SEES

Recalling Titchener’s (1909) original definition of empathy as imaginative projection to perceive something as though from the inside, one of the intriguing features of first-person perspective (1PP) VR using real people (virtual alterity) is that it allows users to see from another person’s egocentric reference point for embodied perception, as though from within the other person’s body. The first step in this process is first-person point-of-view (POV) stereoscopic video to allow users to see what another sees, a literal and direct simulation of visual perspective taking through media representation. First-person POV video attempts to get closer alignment to another person’s embodied orientation and to what Husserl (1989) and Stein (1989) describe as the “zero point” of orientation that the living body has within the spatial world. It is important to note that the user still has his or her own zero point of orientation with its own interconnected perceptual experiences and motor activities. While virtual alterity projects attempt to align these interconnected perceptual experiences and motor activities to another, this does not strip away or replace the user’s own primordial multisensory embodied experience. To the extent that an individual’s perceptual experience is structured by seeing something from somewhere, presenting someone with the opportunity to experience the same events from the same place is a step towards approximating the structure of another’s experience. Stein (1989) writes, “When I now interpret [the body of another] as a sensing living body and empathically project myself into it, I obtain a new image of the spatial world and a new zero point of orientation.” (p. 61) Virtual alterity creates conditions of possibility to access another’s “zero point” of orientation in alignment with the user’s own body. Bertossa et al. (2008) asked volunteers to locate “their center of self, the place 'I am' or of the I-that-perceives” (p. 333), and found that volunteers consistently placed it near the center of their head, regardless of whether they were sighted or blind, Western or non-Western. Alsmith and Longo (2014) similarly observed that subjects asked to point to their perceived self-location indicated the upper face or upper torso. The BeAnother Lab team developed a vest for the classic setup that performers wear to mount the camera at chin-level, and in the body swap the cameras are at eye-level (Figure 21). One of the mistakes I made in filming Paint With Me was that the cameras were placed too high (forehead level), which makes the user feel like they are looking down or inhabiting a very tall body (Figure 22). The reason that self-location is important for virtual alterity is that it presents another’s view from the point which most people identify their sense of self.
First-person POV in VR is more comfortable and convincing than first-person POV in screen-based film media due to the following reasons: 1) head-motion tracking and sensorimotor feedback mirror natural modes of embodied perception, 2) VR headsets isolate visual information to the VE and replace one’s normal visual field, 3) stereoscopy and 3-dimensionality in VEs creates a more realistic rendering of first-person visual perception. Danish film production company Makropol ApS specialize in first-person perspective-taking (1PP) VR filmmaking. The team uses a bicycle helmet camera mount with two Go Pro cameras with a wide-angle fisheye lens placed just above the performer’s eye-level (Figure 23).

Because of the distance between the two eyes in human visual perception, objects seen with the right and left eye are slightly displaced in stereoscopic vision, which influences depth perception. Kolor Autopano video editing software can be used to stitch the two videos (representing right and left eyes, respectively) into one video that captures this slight displacement, and can render stereoscopic video when played through Unity and viewed in the Oculus Rift DK2 or DK3 VR headsets. The Oculus DK2 and DK3 headsets have an external motion-tracking camera that can detect the user’s head and neck orientation and movement in the real world (position tracking) to synchronize the user’s virtual perspective in real time. This avoids forced head movements for the audience, which makes the experience of 1PP video much more comfortable in VR than traditional film media using 1PP. Using this setup, Makropol has created a 10-episode short 1PP VR film series called Ewa that focuses on major events in the life of a young woman (Ewa) and her relationship with her mother with the audience seeing and hearing from Ewa’s perspective.

Huang et al. (2007) write that “tactile, proprioceptive, vestibular signals, etc., also contribute to one’s egocentric reference frame.” (p. 2) New interfaces explore the possibility of sharing other modes of sensory and motor experiences, such as auditory, haptic, and motor experiences. This allows individuals to take new perspectives on others by seeing, hearing, and moving from within interactive virtual environments representing the spatial coordinates of another person’s POV. For instance, Makropol’s films, Ekholm’s (2014) body swap (2014), and Paint With Me all use auditory perspective taking with the Roald binaural earphone and microphones, which capture auditory information from the performer’s point of view and can then be heard (wearing the same earphones) by a user from this same viewpoint. Moreover, the mixed reality setup (combining real and virtual objects) in Paint With Me allows users to share haptic information with regards to the paint brush, canvas, and paint.

3.3.2 SHARING BODILY COMPORITIONS AND MOVEMENTS WITH ANOTHER

Inspired by avatar embodiment protocols, virtual alterity systems also involve visuomotor synchrony and moving from the point of view of and with another person. This creates a new sense of shared embodied interactive space involving superimposing another person’s embodied experience on top of one’s own. This may open a window to what Gallese (2003) describes as the "global shared experiential dimension with others." (p. 175) In Embodied Social Presence Theory (ESP), the body is the nexus of communication in goal-directed and shared activities. Mennecke et al

5 For video covering how these films are made, see: https://vimeo.com/80221836
6 http://www.kolor.com/autopano-video/
7 http://iamewa.com/
write, “The ESP theory suggests that a communicative act in a virtual environment builds on the embodied sense of self and is realized through co-participation in a particular context that is defined, in part, by the symbolic meaning associated with the space that is shared and tools that are used.” The body is attached to one’s sense of self, and therefore sharing embodied space of another and/or with another signifies sharing a very familiar and personal part of oneself, and accessing the other in a place normally associated with one’s own sense of self.

Virtual alterity involves more than just seeing what another sees, but also involves interpreting the actions and mental states of the person who is looking out from that embodied view that is now shared. The body is a communication device and is a critical tool for expressing mental states (Benthall & Polhemus, 1975). The ways that we move are expressive acts, and moving with another while seeing from their embodied view may allow users to feel as though the other’s experience were happening to the user. Virtual Alterity gives new significance to another person’s expressive acts and behaviors because more of the subjective aspects of those acts are shared. This starts with the perspectival alignment with another’s embodied view. This spatial perspectival alignment has never before been accessible externally; instead, it has been a mental projection of imagining oneself in the shoes of another.

De Vignemont and Singer (2006) observed that individuals instructed to follow someone else in a highly synchronized way reported higher cognitive and emotional empathy then when they followed someone in a less synchronous way. By contrast, Santiesteban et al. (2011) found that perspective taking abilities were enhanced by suppressing imitation. Inhibiting imitation is postulated to increase self-other discrimination processes that are key for perspective taking. Thus, further experimentation should explore how perspective taking and imitation are related, such that one can feel more connected to another person, almost literally “more in synch with” another through imitation, but also somehow still notice differences between one’s own and another’s movements that seem to be important for self-other distinctions in perspective taking.

Virtual alterity projects are a starting point for understanding the relationship between imitation and perspective taking. However, virtual alterity projects involve being spatially aligned to and moving synchronously with another, which is a different form of imitation than that which occurs in face-to-face interactions. This may be closer to what Koehne et al. (2016) define as interpersonal synchronization, movements that are synchronous in time but not necessarily similar in form, whereas imitation is similar in form but not synchronous. PWM uses features of imitation and interpersonal synchrony with the Leap Motion hand tracking that aligns users to the shape and form of the painter’s movements while moving synchronously (Figure 24). Adamovich et al. (2009) showed that moving synchronously with another person from the same POV has different neural substrates than non-synchronous observing-then-acting imitation (Figure 25). This is especially useful for teaching fine-motor skills like painting, where the closest approximate in physical reality would be to either look over someone’s shoulder or have two people face one another and paint on a transparent surface, which would involve left-right reversal like a mirror. This was the motivation for stipulating Paint With Me as an expert-novice skills transmission software, as it teaches the skill of painting in a new way by tracing another’s movements synchronously and with precise spatial alignment.
3.3.3 **EXPERIENTIAL PERSPECTIVE TAKING**

Whereas Visual Perspective Taking (VPT) can allow us to see the world from the eyes of another from a spatial standpoint, I argue that new design innovations in multi-sensory virtual environments with embodied narratives create new capacities for *multisensory perspective taking* and *shared agency* such that users can experience how something appears for another and what it feels like to be in another person’s shoes rather than just “seeing through the eyes of another” and seeing what another person sees. Cognitive film theory distinguishes the camera-eye metaphor in the point-of-view shot from the subjective lens (Quendler, 2011). Whereas the POV shot involves shooting from the eye-location of a specific person or character, subjective character perception depicts how external events, circumstances, interactions, activities, and physical stimuli are perceived by the subject). The subjective lens in film is close to what experiential perspective taking aims to achieve in VR.

Experiential perspective taking in VR involves depicting how external events, situations, activities, and physical stimuli are perceived by another person. In her doctoral dissertation, Ahn (2011) writes that, "The fact that people's thoughts and feelings are limited by their body's physical capacities seems to be a big constraint of embodied cognition." (p. 9) She goes on to explain that body type, perceptual apparatus, and means of interactions with the environment configure affordances of human thought and action, and argues that mental simulation is also bound by this restriction. Ahn defines embodied experiences in virtual environments as tools to go beyond the constraints of the body or of prior experiences and to augment the sensory capacities of the human body. Thus, experiential perspective taking allows subjects to see a shared or familiar event, object, task, or situation through the perceptual and experiential lens of another. This allows a more literal and concrete depiction of how someone sees something than narrative engagement and visuospatial perspective taking.

Below I provide specific examples of five VR projects that use this concept of experiential perspective taking. These projects demonstrate the sense of empathy that virtual alterity projects aim to capture, which is translating and relaying the first-person experience of another.

**COLORBLINDNESS**

Ahn, Tran Le, and Bailenson (2015) used embodied simulations to facilitate easy and effective perspective taking. The team showed subjects a task space of sorting colored blocks as it would appear to someone with complete color blindness (achromatopsia) in the Immersive Virtual Environment (IVE) condition, or had subjects read a short textual description of the experience of colorblindness for the cognitive perspective taking condition. Afterwards, the team measured subjects’ willingness to stay after the experiment to help a confederate (who purportedly had color blindness) on the task, as well as the amount of time that subjects stayed after to help. They found that the IVE promoted more helping behavior than simply imagining a scene from another person’s perspective (cognitive perspective taking). The IVE experience also led to greater SOM and attitude change towards persons with disability. This study induces something more subtle than visual perspective taking and allows the subjects to see how the world would appear to a person with a sensory disability. This

![Figure 26. In Ahn et al.'s (2015) study, a confederate (C) works on a color-sorting task. The participant (P) wears a HMD that shows the task space from the confederate's viewpoint, capturing colorblindness.](image)
facilitates empathy because it gives people a practical sense of how to best help someone with colorblindness solve a task, and it shows them the differences between their own task performance uninhibited and inhibited by this disability.

**Sensory Overload in Autism**

Unusual sensory perceptual experiences have been reported in and autism (de Meyer, 1976; Wing, 1969). There have been VEs designed to capture and transmit these unusual sensory experiences. For instance, The National Autistic Society (2016) created *Autism: Too Much Information*⁸, a 360 degree video that shows audiences the subjective perceptual sensory disturbances of sensory overload in autism. The video centers around a child in a mall environment who is overwhelmed by all of the colors, sounds, objects, and people surrounding him. Empirical studies and first-hand reports from sensory disturbances in ASD individuals who have sensory disturbances involving difficulties in processing synchronous stimulation of more than one of the senses, as well as difficulties in recognizing the channel through which stimulation is being received (Jones, Quigney, & Huws, 2003). ASD individuals often also engage in stimulus over-selectivity by hyper-focusing on one specific aspect of an environment, which could be a coping mechanism for the inability to process more than one sense at a time and to focus. *Autism: Too Much Information* captures these types of sensory disturbances, such as being absorbed into the brightness of a red balloon, hypersensitivity to high-pitched noises, etc. This helps audiences understand the subjective character of sensory perceptual experience in ASD, rather than just reading about these experiences, which by description alone can seem very abstract and almost hallucinatory for a neurotypical person (Jones, Quigney, & Huws, 2003).

**Sensory Disturbances in Schizophrenia**

Tichon, Banks, and Yellowlees (2003) developed a virtual reality simulation of a schizophrenic episode, specifically involving the 'hearing voices' (auditory hallucinations) and visual hallucinations. The authors work with a schizophrenic patient to research the psychological and physical feeling of a schizophrenic episode. This VR simulation facilitates effective patient therapy and helps family members and professionals better empathize and understand persons suffering from schizophrenia.

**Motor Disabilities and Chronic Pain**

Jin et al. (2016) created a game called *As If* as an empathy tool for experiencing the activity limitations of chronic pain. Because chronic pain is often invisible and difficult to communicate, the general public have a difficult time comprehending or even believing that chronic pain could persist over six months or more (the duration that categorizes chronic pain). The *As If* game involves connecting dots through whole-body interaction. Participants experience the task normally, and then get randomly impaired with a pain attack that impairs the user’s degree of motor activity and mimics the motor impairment of someone suffering from chronic pain. The researchers measured empathy for chronic pain experience, and demonstrated that the *As If* game acts as a communication media to help enhance

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⁸ http://www.autism.org.uk/vr

*Figure 27. A user in the As If game writes letters while being simultaneously struck with a pain attack in the left shoulder. Image from Jin et al. (2016).*
understanding of chronic pain. However, one limitation to this study is that users are not taking the perspective of one specific person, and thus the experience is not entirely other-focused even though it involves understanding the physical limits of a condition impacting a group of people.

MACULAR DEGENERATION AND HEARING LOSS

Embodied Labs, a technology education company, created The Alfred Lab (2016), a medical training VR application designed to expose young medical students some of the sensory impairments common in elderly patients. Alfred is video designed to capture the experience of high-frequency hearing loss and macular degeneration. The setup involves a 7-minute 360 degree video with random black spots and blurs occluding the visual field to capture macular degeneration and binaural audio that presents 3-Dimensional, spatialized sound with high-frequency sounds filtered out to capture hearing loss. The setup uses Leap Motion hand tracking technology to display a virtual representation of the user's hands and hand movements in the place of Alfred at the table, causing users to associate their own movements as Alfred's. During the 7-minute video, Alfred listens to his family's concerns about his health, experiences a daydream, visits a geriatrician, takes a cognitive test, and receives a diagnosis. The Alfred Lab was created to help doctors understand their patients and to create more empathic listening and compassion. These empathic outcomes are hypothesized to be linked to greater patient satisfaction, as well as treatment and health outcomes.

3.3.4 TRANSFORMED SOCIAL INTERACTIONS

Bailenson et al. (2008) define Transformed Social Interaction (TSI) as Computer Mediated Communication (CMC) that allows people to interact in ways not possible face-to-face. Virtual alterity systems involve an enhanced, technologically augmented and mediated access to someone else’s first-person experience. The user is aware of the other person as a “you” while sharing structures of experience normally associated solely with the sense of “I.” Virtual alterity opens a new interactive space whereby two people orient themselves towards the same object, task, or event at the same time and in the same way (through synchronous movements) while sharing and spatially aligning to another’s first-person perspective. Aligning with another person during a collaborative task or social interaction in this way creates new structures of communication and new expert-novice training environments. This has been especially effective in creative, skillful, and self-expressive performances like dancing, drawing, painting, and playing piano and drums. While virtual alterity lack meaningful social cues such as facial expressions, these environments involve important design innovations for visual perspective taking, joint action, as well as multimodal representations of various cognitive, sensory, and motor expertise or impairment.

3.4 RESEARCH FINDINGS

Two explorative studies aimed to integrate two lines of VR research by examining the beneficial effects of perspective taking combined with embodied simulations. The hypothesis was that adopting the perspective of another while moving synchronously would increase self-other merging and empathic accuracy. Study 1 uses the MBA Body Swap in a simple, preliminary survey
and interview methodology with no experimental conditions. Study 2 uses the PWM setup and explores the impact of media presentation (screen versus VR) of the same footage on empathic and learning outcomes.

3.4.1 STUDY 1: THE MACHINE TO BE ANOTHER BODY SWAP

The Machine to Be Another (MBA) Body Swap is an art performance technology installation that has been exhibited at various art festivals and galleries internationally. The aim of this exploratory study was to examine whether using embodied simulation and self-transposal in VR in a body swap with a person of a different race, gender, and age would increase self-other merging. Furthermore, we examined body ownership and agency illusions as potential mediators for SOM. This study was conducted in collaboration with Marte Roel and Daniel Gonzalez-Franco. Two instruments were used to gather data, a VR survey adapted from Falconer et al. (2014) and the SOM Scale. Additionally, ten-minutes semi-structured qualitative post-body swap interviews were conducted to better understand subjects’ experiences within the body swap.

Participants

Twenty-four (16 female) volunteers were recruited from the Helsinki community during the Interfaces for Empathy Pixelache 2016 weeklong festival 22-25 September⁹. All had normal or corrected-to-normal visual acuity. The ages ranged from 12 to 64 years (M=30.68, SD=13.94). Participants were deliberately chosen to be partnered with someone they did not know of a different age, race, or gender.

Figure 29. Diagram of all equipment used for the Machine to Be Another Body Swap.

⁹ https://empathy.pixelache.ac/
Stimuli and Apparatus

*The Machine to Be Another* is built with openFrameworks and the software is available for anyone to use with detailed instructions available on Github.\(^10\) This study used two separate Lenovo laptop computers connected to Oculus Rift DK2 HMDs with tracking cameras (for head and neck movement tracking) and front-mounted PlayStation 3 USB cameras. Video feeds from both cameras were fed to the other person’s HMD.

The camera and audio feed were controlled remotely through an iPad tablet system running the “Body Swap Controller” on TouchOSC software (Figure 30). Simple ambient music was played into the earphones of each participant so that they could not hear the facilitators. The setup also uses a curtain to separate subjects and two mirrors to show each participant in Phase 1, and the curtain is removed in Phase 2. The entire body swap experience lasts about 7-10 minutes. The screen was dimmed at the end of the body swap and two experimenters helped the participants remove the headset.

![Figure 30. The TouchOSC interface for the BodySwap Controller to administer verbal instructions to participants and adjust screen lighting and camera calibrations.](image)

**Design and Procedure**

Two participants were seated in chairs across from one another, separated by a curtain, and are fitted with the HMD and headphones. Participants were told to sit comfortably and close their eyes. The experimenters calibrated the head and neck tracking cameras and the camera feeds so that they aligned. When everything was calibrated, an experimenter cued the “Welcome” instructions through the Body Swap Controller:

"Please take a moment to breathe calmly and center yourself. You will soon swap bodies with someone else. Feel free to explore your new body. Try to synchronize with the movements you see, and direct them at the same time. Please remember to move very slowly so that the experience is more comfortable. If at any moment you feel dizzy, just close your eyes for a few moments."

\(^{10}\) [https://github.com/BeAnotherLab/The-Machine-to-be-Another](https://github.com/BeAnotherLab/The-Machine-to-be-Another)
The first cue was “Try to look at your hands.” This began an imitation procedure whereby users initiate movements but also follow their partner’s movements within the interaction. If users moved too quickly, the “Move slowly” reminder verbal cue is used. After a couple of minutes, the facilitators entered, waved to each participant, and started the touch, tap, squeeze synchronous touch sequence with each participants using a “1, 2, 3 touch” metronomic system to align the sequence of tactile delivery. The facilitators touched the palm of their hands to the participants’ palms and stroke the participants’ forearms, hands, and fingers. Then the facilitators grabbed the participants’ feet and squeezed their toes. Afterwards, the participants engaged freely in an Imitation Procedure, following each other’s movements. At this point, the facilitators brought in a full-length mirror. Seeing themselves mirrored as another, participants made facial expressions, kicked their legs, and touched their face and hands, still synchronizing movements. The mirrors were removed, the curtain was drawn back, and the facilitators guided the subjects to stand up and walk towards one another. Once the participants were close to one another, they were instructed to shake hands while a facilitator stroked their forearms and wrists synchronously. Participants moved freely for another minute, and then the goodbye message was played, thanking subjects for their time. Experimenters helped the participants remove their headset.

Participants were given some time to recover and to talk with their partner, and after about 10 minutes were approached for a survey questionnaire and interview about the experience. The experimenter stood by to ensure that the participants understood the survey questions. Participants were interviewed individually.

Response Variables
Post-Experience Virtual Reality Questionnaire.

After the Body Swap, participants were given a 5-statement post-questionnaire adapted from Falconer et al. (2014) and shown in Table 1. Participants rated these statements on a 7-point Likert scale ranging from -3 (“Strongly Disagree”) to +3 (“Strongly Agree”) with 0 indicating a neutral response. Falconer et al. (2014) had previously designed this questionnaire to measure the strength of body ownership. The Agency item was rewritten from Falconer et al.’s (2014) original, rewritten to “I felt that my movements were indistinguishable from the movements I saw my partner performing in VR.” This was done to better fit the experimental setup, but this revision may have biased findings. The Features item indicates perceived similarity to the other’s body as a potential modulator for ownership, and TwoBodies measures the extent to which users feel a sense of simultaneous presence in another body while still consciously aware of their own body. While Falconer et al. (2014) used this as a control measure for a BOI, Ekholm (2014) and Jazbec et al.’s (2016) body swap studies found that users experienced this sense of being in two bodies simultaneously while still experiencing a BOI, and thus this study used the TwoBodies item as a measure for this effect.

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>MyBody</td>
<td>“I felt that the body I saw when looking down at myself was my own body&quot;</td>
</tr>
</tbody>
</table>
**Table 1. Survey statements and variables. Adapted from Facloner et al. (2014)**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TwoBodies</strong></td>
<td>“I felt as if I had two bodies”</td>
</tr>
<tr>
<td><strong>Mirror</strong></td>
<td>“I felt that the body I saw when I looked in the mirror was my own body”</td>
</tr>
<tr>
<td><strong>Features</strong></td>
<td>“I felt that my virtual body resembled my own (real) body in terms of shape, skin tone, or other visual features”</td>
</tr>
<tr>
<td><strong>Agency</strong></td>
<td>“I felt that my movements were indistinguishable from the movements I saw my partner performing in VR.”</td>
</tr>
</tbody>
</table>

**Self-Other Merging**

Participants were given the Inclusion of the Other in the Self Scale (Aron et al., 1992). This scale measured how close the participants felt to their partner in the body swap. The scale depicts seven drawings of increasingly overlapping circles, starting with the first picture of non-overlapping circles and the seventh picture of two almost completely overlapping circles (Figure 32). Participants were instructed to select the figure that best captured how they felt in relation to their partner in the body swap.

**Semi-Structured Interview.**

Experimenter conducted 10-minute interviews with subjects to gain more insight into what was gained from the virtual simulation and experience (media affordances), to what extent subjects felt more or less empathic after the experience, and how subjects thought about the medium as a potential empathy training intervention. All subjects were asked the same 5 questions with adapted follow-up questions.

**Results and Discussion**

The MyBody and Mirror ratings were generally quite low (M = -1 for MyBody and M = 0 for Mirror), whereas the rating for Agency was quite high (M = 2). Almost half (48%) of all subject responses for the MyBody statement were Mostly Disagree (-2) or Strongly Disagree (-3). By contrast, 57% rated Strongly Agree (3) or Mostly Agree (2) for Agency, with 78% agreeing, 8% neutral, and 24% disagreeing (-3 to -1). The MyMirror condition was divided between 56% disagreeing and 24% agreeing (20% neutral), and Features was inversely divided with 56% agreeing, 20% disagreeing (24% neutral). Thus, the MBA body swap does not seem to induce a Body Ownership Illusion, but there is still an Agency Illusion. The TwoBodies item was rated primarily disagree (72%), with 28% neutral and 20% agreeing. Subjects rated self-other merging quite (SOM) highly (72% rated 5 or higher). A linear regression was conducted with self-other merging (SOM) as the dependent variable and MyBody, Mirror, Agency, and TwoBodies as the predictors. SOM was positively correlated with Agency ($r = .786 \ p < .004$), but SOM was not statistically significantly correlated with any of the other items. Thus, participants who rated higher Agency ratings also reported higher SOM.

During the interview, participants reported that the MyBody question seemed strange because they were aware that the body they saw was the body of another real person and therefore not their own. The unique finding from the interviews is that during the imitation procedure participants reported a sense
of fluidly moving together with their partner wherein initial turn taking dissolved and they lose sense of whether they are initiating or following movements. Koehne et al. (2016) describe this movement fluidity as *reciprocal interpersonal synchrony*, distinct from *unilateral synchronization* which specifies moments when one member of a dyad, the follower, adjusts his or her movements to entrain to their partner (the leader), which causes the follower to *produce* synchronization and the leader to *perceive* synchronization. Research on the MBA body swap should examine whether perceived and produced interpersonal synchrony during the imitation procedure lead to similar increases in cognitive empathy task performance. I postulate that by sharing a perspective and moving together in the MBA body swap, the participant’s sense of self-directed action gets blurred into an interpersonal coordination which is neither *mine* nor *yours* but something in between. This is an effect that the BAL team describe as a Shared Agency Illusion (SAI). It is possible that the SAI deconstructs aspects of the sense of self as author, owner, or initiator of an action, in ways that enhance feelings of interconnectedness. The SAI might impact users’ sense of their own mental autonomy (Metzinger, 2015), which is one’s perceived mental agency (ability to direct and control one’s mental actions), by impacting perceptions of explicitly selecting goals and rational guidance of actions. Users report experiencing a shared sense of being that is suspended between the normal sense of bodily-self ownership and the normal sense of other as independently embodied.

### 3.4.2 Study 2: Paint With Me

Study 2 compared a previous mixed reality setup of PWM (see Gerry, 2017) with the same stereoscopic *POV* video shown either in VR or on a 2-Dimensional large screen monitor. There were two experimental conditions: Embodied Experience (EE) and Screen (S). In the EE condition, subjects used a real canvas, easel, paint, and paintbrush physically matched to the virtual tools presented in the VE, and the participant’s hand is superimposed on top of the pre-recorded *POV* video with real-time motion tracking. In both conditions, participants also heard the painter describe her creative process and imagination while she paints, but in the EE condition the audio is binaural and captures sound heard from the painter’s *POV*. Participants were instructed to follow the movements of the painter and paint on their own canvas.

32 subjects (18 female) were recruited from Copenhagen University, ages 19 to 32 years (M=23.21, SD=6.59). The aim of this study was to test whether embodied experiences with perspective taking in VR (virtual alterity) could induce greater empathic accuracy, SOM, and body ownership than traditional film media. Empathic accuracy scores were measured through a test inspired by Ickes (1997), in which the painter had time-stopped her own video of herself painting at moments when she had a unique thought or feeling. The painter came up with short phrases to describe these thoughts and feelings. After watching the video in either IVE or on a screen, subjects also watched short video clips capturing the moments the painter had previously marked. The subjects were tasked with generating their own phrase to capture their inferences about the painter’s thoughts and feelings. Table 2 summarizes responses ranked as very similar from the Empathic Accuracy Scale.
Participants in the Embodied Experience (EE) condition had statistically significantly ($p < .05$) higher scores on SOM, Empathic Accuracy, Presence, and Agency than the Screen condition, indicating that the main effect of the experimental condition was significant. Thus, embodying another in IVE is more effective in promoting understanding of another’s changing thoughts and feelings than screen-based media. Moreover, subjects in the EE condition did not report experiencing BOI but did report an Agency illusion. This Agency illusion involved the sense of moving together with the painter and her intentions getting blurred with the subject’s own intentions. After the main task (painting), subjects were interviewed for 10 minutes. These interviews indicate that in the screen condition, subjects found watching and then imitating the painter to be extremely challenging. When we engage with others in joint tasks, our attention is divided between the task itself and observing the other person’s actions. PWM offers one solution to how this challenge may be overcome. By contrast, subjects in the IVE condition reported a very intimate experience of being brought into the artist’s inner world with a sense of creating something with her.

### 3.5 LIMITATIONS OF VIRTUAL ALTERITY SYSTEMS

One of the limitations of virtual alterity systems is that the user cannot see the face of the person whose perspective they embody. This highlights a much deeper limitation of virtual alterity, which is that simply seeing the hands, torso, and legs of another from a first-person perspective significantly limits access to socially salient information such as gaze, gesture, posture, and facial expressions. The MBA overcomes this limitation in two ways: 1) the performer looks in a mirror, in which case his or her face may be partially obstructed by cameras or a VR headset and 2) setups are used with persons who are physically co-present in the same space and can therefore interact face-to-face before or after. Another limitation of virtual alterity systems is the lack of feedback and interaction. Thus, it would be useful if users could ask the performer questions about his or her experience and communicate during the experience. Current setups do not involve this possibility. Thus, the setups are not entirely reciprocal.

Whereas previous studies explore empathy for marginalized outgroups, out-group members, disabled persons, or empathy between groups around a conflict, PWM and MBA do not target a specific issue in empathy towards a specific population. This limits tracking these interventions in facilitating empathy because the empathy evoked does not have a direct translation towards a group of people or a specific conflict. Further research will identify specific empathic targets, specifically by focusing on particular emotional events or specific intergroup conflicts.
Virtual alterity setups do not necessarily involve an affective response to another. Ahn et al.’s (2013) study indicates increased helping behavior, and the compromise of subjects’ own free time after the experiment is indicative that subjects felt empathic concern. One potential direction for future research is to use the PWM setup but to have the painter paint about an emotional event. Future research will further explore prosocial attitude and behavior changes after virtual alterity interventions.

The last limitation of virtual alterity setups is that they are focus on translating first-person experience from one person to another. However, empathy may not be about me translating your first person experience, but may instead be something that is rooted in second-person, face-to-face interaction. However, even if this is the case, virtual alterity systems still present a tool for the communication of first-person experience, and even if this tool is not the best model for empathy then it will still help pave the way for future research.
Conclusions and Directions for Future Research

This thesis reviewed the most significant research contributions to understanding virtual reality as a tool for empathy, specifically focusing on avatar embodiment and perspective-taking setups. One way VR is important as a tool for empathy is that it can overcome barriers to empathic activation. VR can change perceived self-other overlap towards greater social inclusivity. Avatar embodiment setups offer promising tools to mitigate stereotypes and prejudices, but these setups lack an other-directed focus for empathic engagement. Another reason that VR is important as a tool for empathy is that it can simulate what would otherwise need to be conceptualized or imagined. Perspective-taking VR present another person’s point of view concretely rather than conceptually, aiding cognitive load and imagination.

VR is also useful for representing other’s first-person, embodied experiences. Virtual alterity projects attempt to deepen and expand the notion of perspective-taking to include more multisensory and experiential dimensions. These setups involve a more other-directed perspective taking while sharing the bodily space of another real person through synchronous movement in joint tasks. The key to these virtual alterity setups is that they open a window to another’s lived experience and subjectivity while synchronizing and aligning to the other during interactions in ways that also highlight coordinated activity, one key feature of intersubjectivity. This matches the phenomenological proposition for empathy as a heightened awareness of another as a subjective and intersubjective person. However, one of the limitations is that research is currently inconclusive as to whether virtual alterity projects increase other-directed empathic action.

Results from two virtual alterity projects suggest that agency may have a significant role in empathy. Whereas previous research stipulates body ownership illusions as the main mechanism beyond transformed social perceptions, virtual alterity research indicates that agency illusions may also have a role in transforming social perceptions. Specifically, agency illusions disrupt certain aspects of egocentricity biases and increase a sense of interdependence and co-emergence with others during joint actions. Future research can investigate the role of agency illusions in VR, specifically the shared agency illusion, in empathic processes and outcomes. Moreover, future research can combine features proposed for virtual alterity systems to allow people to more fully engage with the first-person phenomenological experience of one another.
References


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