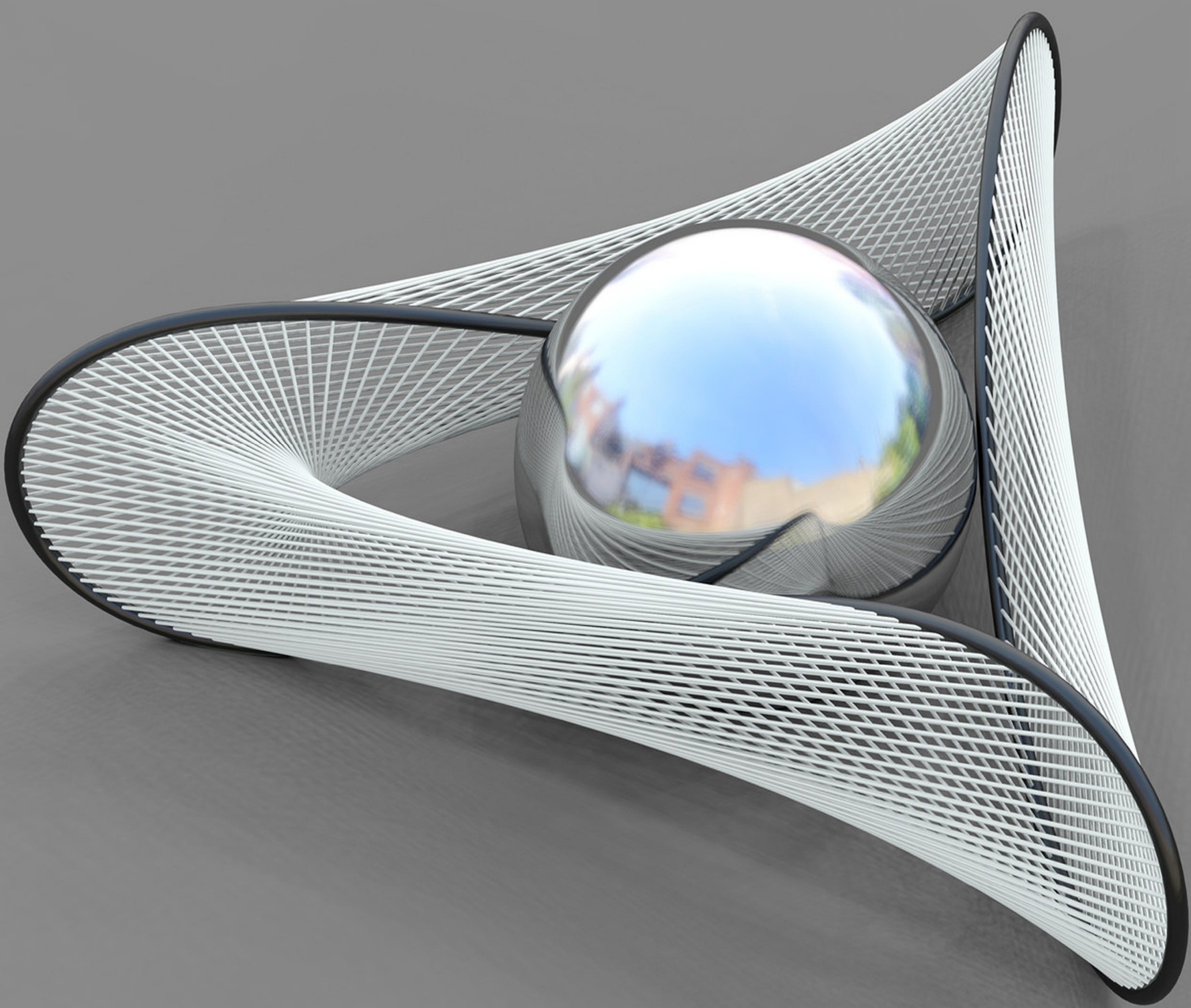
Journal of
Virtual Worlds Research
jvwresearch.org ISSN: 1941-8477

Assembled 2016

September 2016 (Part 2)
Volume 9 No. 2



(c) Art by: Francesco De Comité, University of Lille

Volume 9, Number 2
Assembled 2016 (Part 2)

September 2016

Cover image: Hypocycloid. Francesco De Comite, University of Lille
https://flic.kr/p/HCC6YR

Journal of
Virtual Worlds Research
jvwresearch.org ISSN: 1941-8477

Volume 9, Number 2
Assembled 2016 (2)
September, 2016

Technology and the Not-so-Stable Body: "Being There" in the Cyborg's Dilemma

Sean Philip Gleason
Ohio University, OH, USA

Abstract

Will virtual worlds one day be perceptually similar to everyday life? Could virtual reality (VR) provide a platform for individuals to dialogue about pressing social or political issues? From the *Ready Player One* and *Matrix* franchises, to the science fiction of Isaac Asimov, the communicative and political implications of hybrid human/machine virtual worlds have been heavily theorized. Yet, fundamental questions remain as to whether or not VR could ever substantiate the breath and scope of embodied, non-virtual experience. The following paper examines whether VR platforms are capable of providing an authentic sense of "being there" in digital spaces. Drawing from empirical findings in cognitive neuroscience, scholarship on virtual presence, and the phenomenology of perception, this paper argues that any attempt to communicate embodied presence within VR must account for the role of motoric action in structuring a vividly experienced worldhood. To this end, increased sensory feedback from new technologies will add to the life-like quality of virtual reality only insofar as this feedback is filtered through an action-oriented body image.

At the center of communication rests the body, the fleshy gateway to the mind.

— Frank Biocca (1997), "The Cyborg's Dilemma"

1. Introduction

Everyday experience poses a problem when we stop to consider exactly how we accomplish the many bodily actions constituting what Hollan and Stornetta (1992) term "being there." On the one hand, the vast majority of everyday action requires little conscious intent or direction: even complex actions, such as driving a car or playing guitar, can be performed with minimal attention. Upon further reflection though, these seemingly rote actions necessitate intricate coordination between finely tuned perceptual modalities. In reaching for my coffee mug, for instance, I rely on a multitude of sensory inputs to furnish the basic low-level information needed for higher cognitive processing. I must receive proprioceptive information about the orientation of my arm in space, make a visually based judgment regarding the absolute depth and distance of the mug in order to determine the proper grip aperture (opening) of my hand, and receive haptic (touch-based) feedback announcing when my hand has reached its target. In addition, as a voluntary movement, it is also necessary that I am able to estimate the accuracy of my motor commands in real time by means of an efference-based forward model of intended action, which compares predicted sensory feedback with the actual state of events unfolding before me (Clark, 2015). In this sense then, action, experience, and knowledge regarding the world around us is unquestionably mediated by the body.

It thus seems that knowledge of the subjective nature consciousness—what some philosophers (Nagel, 1974) refer to as *qualia* or the "what it is likeness" of experience—cannot occur without a strong understanding of the role of embodied perception. Understanding this subjective quality of experience is generally not possible though without conceding that perceptions, beliefs, and assumptions about our surroundings exist because, in the words of phenomenologist Maurice Merleau-Ponty (2005), the body functions as a "sensing thing" (p. 6). In this manner, the experience of reaching for a coffee mug would be vastly different for myself as it would for someone who is visually impaired, missing a limb, or even an alien who has more than two prehensile limbs. Experiences of "being there" are largely determined by the type, quantity, and integration of sensory feedback provided by the body.

Too often we treat the study of embodiment, writ large, as an imperative— "just do it"—with precious little thought devoted to how (and to what extent) our bodies shape conscious experience. It is not enough to stop at the conclusion that we should simply pay heed to the body in scholarship. Rather, we must acknowledge that questions surrounding embodiment are quite complex. The bulk of scholarship regarding embodiment fails to consider how feelings of bodily ownership, agency, and presence may extend beyond the limits of the organic body. Drawing from recent findings in cognitive neuroscience on multisensory integration and the phenomenology of perception, the following paper considers how traditional notions of embodiment and presence obscure the multitude of ways in which the body interacts with (and is mediated by) new technologies. The role of prosthetic technologies, teleassistance, and virtual reality (VR) are thus considered as pathways to cultivating feelings of presence that problematize classical ideas of the organic body in what Biocca (1997) calls the *cyborg's dilemma*. This alternative view of embodiment holds significant implications for the study of future technologies by considering "being there" as a new plateau of virtual experience. Although it is common to acknowledge that experience is mediated by new technologies, this paper provides an empirically robust defense of the idea that the subjective qualities of non-virtual life may one day be transposed to a virtual world in a positive phenomenology of "being-there." To facilitate this transition though, proponents of virtual reality must increase our ability to author motoric action in virtual spaces.

2. Theories of Presence, Technology, and "Being There"

It may seem strange to question what is meant by the concept *presence* since, as Kwan Min Lee (2004) notes, feelings of non-virtual presence are often naturally accepted in everyday action. As an individual prepares dinner, takes his or her dog for a walk, or reaches for a coffee mug, the sense of presence derived from these activities remains inextricably linked to the actions and physical location of the body. In such examples, feelings of presence largely coexist with a stronger phenomenology of "being there" in the world (Clark 1997a, 1997b; Biocca, 1992a, 1997; Hollan & Stornetta, 1992). As first described by phenomenologist Martin Heidegger (1962), this notion of "being there" describes a mode of being-in-the-world, in which we are active participants (Clark, 1997b). In the case of "being there", an individual is aware of his or her body as a unique object in the world (Heidegger, 1962; Longo et al., 2009; Merleau-Ponty, 2005). Although bodily action may be mediated by other objects—for example a knife to cook dinner with or a leash when walking a dog—general experience holds that we do not attribute a feeling of ownership towards these objects in the same way that one feels ownership over an arm or leg.

Questions of presence become increasingly complex though when considering the role of mediated communication and imagination. Could an individual, for instance, attribute a feeling of imaginative presence when reading an intriguing book or viewing a captivating television show? What about instances of interpersonal communication mediated by immersive technologies such as videoconferencing? Theories of presence, it thus appears, must take into account the varying degrees to which we may feel "present" in mediated and virtual environments. Theories of presence are also complicated by new technologies bestowing, as Biocca (1997) notes, "the compelling perceptual sensation of being in a place other than where your physical body is located" (p. 18).

Scholars of presence theory distinguish three types of presence—*social presence, physical presence,* and *self-presence*—depending on the immersive quality of the experience and the degree of multisensory feedback received (Biocca, 1997). *Social theories of presence* highlight the ability of immersive technologies to obscure the spatial and temporal differences between individuals to sustain feelings of "being with" another through the use of visual and/or auditory feedback (Lee, 2004a, 2009). This distinction between "being there" and "being with" is important as instances of social presence require that participants limit contradicting sensory feedback in order to imagine themselves alongside others (Lemish, 1982; Lombard, 1995). Thus, social theories of presence illustrate what Lee (2004) terms a "psychological state in which the virtuality of experience is unnoticed" during communication with other humans or artificial social actors connected by new technologies (p. 32).

Examples of social presence can include computer-supported cooperative work (CSCW), internet chatting, videoconferences, as well as social interaction with artificial intelligence such as chatbots (Lee, 2004). Instances of social presence can take place even if the technology fails to provide sensory feedback outside of visual and auditory stimuli. In contrast, technologies that evoke a sense of *physical presence* typically provide the user with rudimentary proprioceptive and haptic feedback (Goertz, 1982). Instances of physical presence transcend the imaginative realm of social presence as participants experience "virtual physical objects and environments that have an authentic connection with the corresponding actual physical objects and environments" (Lee, 2004, p. 41). As a result, the feeling of physical presence means that an individual is less likely to recognize the mediated nature of virtual objects in space.

The possibility of physical presence offers designers of virtual spaces the ability to create a life-like virtual world with the integration of additional sensory feedback. Yet feelings of physical presence do not necessarily ensure that participants will extend a sense of ownership over virtual avatars. It is quite possible that an individual could feel physically present in a virtual space without feeling as if the avatar was an extension of his or her body. Given that feelings of ownership are linked to a robust phenomenology of "being there," the experience of virtual spaces will arguably remain second-rate until researchers consider the relationship between virtual motoric action and the sensory feedback this action produces (de Vignemont, 2007). To this end, the study of *telepresence* provides a number of interesting case studies offering hope for those seeking to extend a sense of "being there" to virtual realities.

Marvin Minsky (1980) introduced the term telepresence to explain the possibility that humans could identify with and, in a sense, be physically transported to remote workspaces. The earliest reports of telepresence (in which a user feels psychologically connected to a machine) originated with the development of rudimentary claw-like systems (teleoperators) designed to manipulate nuclear and other toxic waste (Clark, 2007). Experiences of telepresence demonstrate the complex relationship between embodiment and feelings of physical presence accompanying the use of new technologies designed to communicate motoric action in distant and virtual spaces.

In the case of telepresence, perceptual adaptations made possible by teleoperators are facilitated via a combination of visual inputs as well as the subject's ability to move and act in remote spaces (Hein, 1980; Clark, 2007). As Clark (2007) notes, feelings of telepresence are the strongest when motoric commands and action are constructed in a one-to-one ratio, emphasizing the implicit connection between action and perception: "The user, in this case, feels as if he or she is actually touching and manipulating the (modestly) distant materials" (p. 423). In the most emphatic cases of telepresence, low-level commands (such as manipulating a joystick) correspond exactly to robotic movement with very little temporal delay. As long as the motoric commands issued to the robotic prosthetic mimic the type of motor commands used for bodily action, individuals may perceive robotic and virtual devices as literal extensions of the body.

Feelings of physical presence in teleoperator systems have been documented regardless of whether the robotic action is scaled up or down to account for the size or weight of the object manipulated (Clark, 2007). In this way, telepresence can occur even if the directed action would be impossible by the organic body in everyday experience. For instance, Minsky (1980) details one experimental apparatus where subjects received visual feedback from a remote TV camera. Using a helmet to track neck movement, the video camera adjusted its relative position to simulate the actions of the participant at a two-to-one ratio. As a result, everyday actions—for example turning one's head 30 degrees—produced the non-veridical sensation of having a "rubber neck" that now accommodated objects in a visual field of 60 degrees. Most notably, this "telepresence eye" allowed for the feeling of turning your head 180 degrees to view rear-facing objects. Although this experience was unsettling, the impossibility of this scenario did not detract from subject's reported sense of being physically located in a virtual environment.

Minsky's (1980) findings offer hope to futurists who seek to instill a sense of "being there" in virtual spaces that do not conform to the physical realities of organic life. At the same time, the one-to-one ratio requisite for telepresence seems to have more to do with how commands are communicated than the expected capabilities of the machine. As demonstrated by Minsky's experiments, what matters most—in terms of establishing a sense of ownership—is how various motoric commands are communicated to an avatar rather than how realistic or life-like the anticipated sensory feedback may be. In this manner, multimodal sensory feedback tells only part of the story in terms of presence; it is also equally important to consider how motor commands and action-based feedback are communicated between human and machine. As opposed to telerobotic systems that operate via high-level abstract commands (e.g., “fetch me my coffee mug”), instances of telepresence are highest when teleoperators are controlled by low-level commands that cede supervisory control over all movement to the operator (Sheridan, 1992; Clark, 2007). In other words, an individual is more likely to report being physically present in a virtual space if tasked with parsing out the finely tuned motoric action of an avatar or interface, regardless of how realistic the received sensory feedback is. This point is especially salient for scholars of new technology who study how virtual realities may be harnessed as a communicative medium. To this end, the study of motor emulators, efference-based anticipation, and other comparator/feed-forward mechanisms of motoric action may be useful in bridging the gulf between the body and digital technologies (Grush, 2004).

Although it may be premature to evoke the artificial worlds presented in *Ready Player One, Avatar,* or *The Matrix,* it seems more than reasonable that one day our experience of self—in terms of bodily awareness, feelings of ownership, and a sense of presence when undertaking motoric actions—may be largely mediated through virtual spaces. Already great strides have been made in providing multisensory feedback through technologies such as haptic gloves; virtual reality headsets; and even the “omni treadmill”—an innovation allowing users to navigate virtual worlds on foot. For more budget-minded fans of VR, the Google Cardboard project (https://www.google.com/get/cardboard/get-cardboard/) offers directions for converting compatible phones to VR headsets for the cost of scrap cardboard, Velcro, magnets, and a pair of old 45mm lenses.

The immersive nature of VR is not without its limitations: user induced nausea is one commonly reported side effect. Despite these challenges, there is continued optimism that artificial reality platforms will one day produce an authentic experience of self-presence. Biocca (1997) defines self-presence as:

> *. . . the effect of a virtual environment on the perception of one’s body (i.e. body schema or body image), physiological states, emotional states, perceived traits, and identity. To use a phrase, self-presence refers to the effect of the sensory environment on mental modes of the self. (p. 22)*

In contrast to social theories of presence —in which individuals merely fail to notice the mediated nature of a communication medium—theories of self-presence examine how new technologies substantiate feelings of bodily presence in virtual reality as individuals identify themselves with virtual avatars (Steuer, 1992).

In spite of the technological advancements in virtual reality, the biggest challenge to developing self-presence in digital spaces involves achieving an authentic sense of “being there.” Whereas, many communication mediums are immersive, engendering a truncated sense of physical, social, or even self-presence, researchers have yet to successfully transpose the totality of embodied experience to the domain of virtual space. “Being there” transcends mere presence in that we are disposed to believe that the virtual objects we perceive are really out there in the external environment (Biocca, 1997; Clark, 2007; Hollan & Stornetta, 1992; Minsky, 2010).

Biocca’s (1997) account of self-presence suggests that the potential for a phenomenology of “being there” rests in a virtually augmented body image and schema. In the following section, theories of embodied cognition are introduced as a way to understand the possibility of augmented body images through VR and other new technologies. Given Biocca’s claim that users of virtual space make use of affordances (i.e., the possibility of action) “in the environments from which they perceive the structure of the virtual world in ways similar to the manner they construct the physical world,” the relationship between the body image and an experience of "being there" need not be necessarily bounded to the organic corporal subject (p. 13). This realization is further aided by recognizing bodily affordances and sensory modalities as action-oriented communication devices.

3. Embodied Cognition and the Body Image

The most basic questions of embodiment investigate how the body generates knowledge about the world around us. More specifically, theorists of embodied cognition consider how perceptual and motor systems shape concepts (e.g., color concepts, spatial-relational concepts, etc.) and reason (Lakoff, 1999). Drawing from the work of philosopher Hubert Dreyfus (1972), Varela, Thompson, and Rosch (1991) note that accounts of *embodied action* advance two fundamental claims regarding the relationship between the body and cognition: (a) cognition depends on the type of experiences that come from having a body, and (b) individual sensorimotor capacities are embedded in biological, physiological, and cultural contexts. As Varela et al. conclude:

> *Knowledge is the result of an ongoing interpretation that emerges from our capacities of understanding. These capacities are rooted in the structures of our biological embodiment but are lived and experienced within a domain of consensual action and cultural history. They enable us to make sense of our world; or in more phenomenological language, they are the structures by which we exist in the manner of "having a world." (p. 149-50)*

This ability to give structure to the world around us (i.e., "having a world") originates from both sensorimotor feedback and the manner in which this information is utilized by the brain to model and predict behavior. In this sense, proponents of embodied cognition favor an account of consciousness that recognizes the causal role of the body in shaping higher-level cognitive processes (Wilson & Lucia, 2011).

Fortunately, some of the clearest examples of embodied cognition are provided in everyday experience and action. For example, Lakoff and Johnson (1990) consider language use as an activity rooted in embodiment. Through the study of orientation metaphors, Lakoff and Johnson demonstrate that spatial concepts such as "up," "down," "beside," and "upon" are ultimately founded on the experience of our bodies in space: "such metaphorical orientations are not arbitrary. They have a basis in our physical and cultural experience" (p. 15). Beyond the metaphorical capacity of language though, Lakoff and Johnson (1999) also consider how even the most basic communication of an individual's spatial orientation is in fact linked to a subject-based (*egocentric*) conception of space. In the domain of everyday experience then, perception and action are ultimately informed by sensory input as well as higher-level cognition of ourselves as acting, moving, and feeling agents.

Embodied cognition also illustrates the role multisensory integration of perceptual modalities (e.g., taste, touch, smell, proprioception, etc.) play in communicating spatial orientation. One example provided by Briscoe (2014) considers exactly how humans integrate visual information about the world around us in a coherent sense of egocentric space. As Briscoe (2014) notes, "when you see a plate on the table, you see among other things its direction and distance from your own body as well as its three-dimensional orientation relative to your line of sight" (p. 203). Briscoe's example is illustrative because it demonstrates perception to be a multimodal affair: visual feedback is relatively useless unless considered against the proprioceptive orientation of the body in space to determine the distance and location of an object.

Likewise, for Evans (1982), the subject-relative perception of spatial content founds a spatial coding system, used for forming and enacting motoric action, based on the natural dispositions and limitations of the body. There is no consensus, however, about *how* egocentric space is conceived as an embodied perceptual experience. For instance, Bermúdez (2005) reduces egocentric spatial coding to the apex of the visual field (i.e., the convergent point of binocular vision). Peacocke (1992), on the other hand, identifies the determining factor of egocentric space to be based in the relationship between our visual field and the orientation of the torso towards a given object. Finally, Cassam (1997) locates egocentric spatial knowledge relative to a holistic body image including the torso, neck, head, and other appendages.

Despite the lack of agreement over exactly how sensory modalities interpret the body in space, the concept of egocentric spatial coding is important for scholars of virtual reality. No matter the quality or scope of sensory feedback produced by virtual technologies, a sense of "being there" in VR is largely impossible if this feedback is not integrated, via egocentric spatial coding, into a virtual avatar. As theories of egocentric spatial location demonstrate, knowledge claims about the world around us often rely on the multimodal integration of sensory feedback. To this end, one popular theory to account for holistic feelings of bodily ownership, awareness, and agency proposes the idea of a body image as a cognitive heuristic allowing for the integration of multisensory information (O'Shaughnessy, 1980, 1998). Under this account, bodily action and perception rely on an egocentric representation of the body to determine how—at any instance of time—our body is disposed to take action (de Vignemont, 2015). In sum, the body image acts as a multisensory representation of bodily location, affordances, and potential for action. For proponents of VR then, it is important to consider how new virtual technologies may augment the body image to substantiate a sense of "being there."

Sensorimotor theories of embodied cognition stress that bodily experiences are qualitatively different from all other objects in space. As Merleau-Ponty (2005) writes, "if my arm is resting on the table I should never think of saying that is *beside* the ashtray in the way in which the ash-tray is beside the telephone" (p. 112, emphasis in original). The whole body, upon this account, is not reducible to an "assemblage of organs juxtaposed in space" but instead relies on a body image informing perception and motoric action (p. 112). In this regard, we may distinguish the body image as a system of conscious "perceptions, attitudes, and beliefs pertaining to one's own body," from the *body schema* as a "non-conscious system of processes that constantly regulate posture and movement" (Gallagher, 2005, p. 234). Representations of body image are adept at explaining how individuals might come to non-veridical misrepresentations of their body when bodily perception is fundamentally at odds with physical reality (de Vignemont, 2015). In particular, disorders such as phantom limb pain (Merleau-Ponty, 2005) and the feeling of additional (*supernumary*) phantom limbs (Miyanzawa et al., 2004) have been linked to disruptions of the body image. In this manner, disorders affecting feelings of corporeal ownership demonstrate the body image to be malleable. What is more, if an individual's body image can be augmented there is hope that virtual and prosthetic technologies could be integrated, via discrete motor planning on the part of a virtual avatar, to instill a subjective sense of "being there" within virtual environments. To do so, however, would require that we "hack" the affordances of the organic body image through virtual multisensory feedback loops and low-level motoric action to engender a robust phenomenology within VR. Once again, it is not enough to simply mirror life-like sensory feedback through prosthetic virtual technologies such as haptic gloves or VR headsets. In order to instill a sense of "being there," this feedback must be integrated into a virtual body image through motoric planning and action.

With respect to new technologies, the body image and body schema provide a noteworthy avenue for examining how we might augment bodily representation to sustain a sense of "being there" in virtual worlds. Within the domain of everyday action though, motoric action and movement are often accomplished via the manipulation of external objects in our environment. For example, a skilled billiards player must exert precise control over a pool cue—as an extension of the arm—to pocket a ball. Empirical research (Farne & Ladavas, 2000; Maravita et al., 2002) also demonstrates that tactile receptive fields in the hand can be elongated to partially include external objects after extended use. As a result of these empirical findings, some theorists of cognition (de Vignemont, 2007; Maravita & Iriki, 2004) have not ruled out the possibility that prosthetic devices and tools could be integrated into a body schema. For the study of VR then, the possibility of integrating virtual limbs or prosthetic equipment into the body image exists as an exciting possibility for reaching an authentic phenomenological experience of virtual worlds.

As de Vignmemont (2007) posits, feelings of ownership regarding the body image and schema are neither static nor restricted to the organic corporal body. Extended to the domain of virtual reality though, this tentative conclusion anticipates a further question of whether or not a feelings of ownership over robotic and virtual limbs would be phenomenologically similar to the sense of ownership over other parts of the body. After all, even in the case of tools manipulated in the non-virtual world (e.g., a hammer) individuals do not manifest the same care towards these external objects that they would extend towards their own body parts (Ehrsson, 2012). When using a hammer to drive a nail, one can drop, misplace, and even damage the tool without fear of physical pain, anguish, or other negative bodily experiences.

Communicating a sense of "being there" probably requires the ability to extend ownership over a virtual avatar in the same way that an individual can be said to "own" an arm or a leg. This notion of *total telepresence*, however, has been questioned by noted theorist of artificial intelligence Herbert Dreyfus (2000) who offers a number of objections to the idea that we could ever achieve a sense of "being there" relative to virtual technologies. Key to Dreyfus's argument is that virtual communication: (a) precludes us from rendering physical assistance or being harmed by others in a digital world and (b) fails to establish the level of physical intimacy marking everyday embodied experience. For Dreyfus then, "even the most sophisticated forms of telepresence may well seem remote and abstract if they are not in some way connected with our sense of the warm, embodied nearness of a flesh-and-blood human being" (p. 62).

It is important to note that Dreyfus's objections do not categorically reject the possibility of "being there." Rather, his rejection is predicated in the inability of virtual media to provide timely multisensory feedback in a manner similar to the everyday experience. To this end, experimental findings regarding the relationship between feelings of ownership and multisensory feedback involving the "rubber hand illusion" offer some hope. To induce this body-transfer illusion, individuals view a rubber prosthetic hand while their own hand is hidden behind a small partition. Tactile stimulation is then applied to the participant's hidden hand at the same time that the rubber prosthetic is stroked. Ehrsson (2012) reports that only approximately 30 percent of the population is immune to the illusion; the remaining 70 percent express various feelings of ownership over the prosthetic provided that: (a) the temporal delay in haptic feedback (i.e., the stroking) takes place within 500msec of each other, (b) the spatial configuration of the rubber hand mimics the position of the participant's real hand, and (c) the rubber hand is placed within 27.5mm of the real hand. Moreover, experimental results—confirmed by fMRI imaging—suggest that the intermodal interaction between vision, touch, and proprioception provides a strong enough sense of ownership to induce fear when the rubber limb is threatened by actions such as bending it backward

(Armel & Ramachandran, 2003) or stabbing it with a needle (Ehrsson et al., 2008; Petkova & Ehrsson, 2009).

The rubber hand illusion offers one potential pathway for instilling a sense of ownership over virtual appendages given that the prosthetic is integrated into a participant's body image despite mediated sensory feedback. Ehrsson (2012), following the empirical studies of Slater et al. (2009), also suggests that it may be possible for individuals to maintain ownership over a virtual hand so long as "its movements are temporally and spatially congruent with the movements of the real hand" (p. 788). Limited scholarship (Cole et al., 2000) supports this claim: after guiding robotic arms through a virtual reality apparatus, subjects reported fears that the virtual object manipulated might cause bodily harm if dropped. The result, in the words of Cole et al., was a realization of "just how plastic and fragile the sense of ownership over our bodies is" (p. 167).

The ability to (a) augment the body image to expand a sense of ownership over extra-bodily objects and (b) demonstrate a concern for objects manipulated in virtual spaces chips away at Dreyfus's (2000) contention that we would be unable to extend a sense of physical intimacy over a virtual body. At the same time, experimental research also suggests that the timing—rather than quality—of feedback may be an overlooked condition for cultivating an authentic sense of "being there" in VR. If such feedback is utilized to undertake virtual motoric action, which remains congruent with the type of sensory perception experienced in the real world, it seems reasonable that we may one day treat organic and virtual bodies as phenomenologically similar. As Clark (2007) posits:

> *If the correlations are reliable, persistent, and supported by a robust, reliable causal chain, then the body-image that is constructed on that basis is well grounded. It is well grounded regardless of whether the intervening circuitry is wholly biological or includes non-biological components. (p. 424)*

Clark's larger lesson then is that embodiment is "essential yet negotiable" in regards to perception (p. 427). With this in mind, reliable integration of virtual technologies is not totally determined by the amount, or quality, of feedback present. Rather, the key to including non-biological components within the body image resides in how multisensory information is processed by the brain to accomplish motoric action.

4. Dual Visual Systems and Virtual Motion Sickness

Prior scholarship on "being there" in VR has stressed the importance of (a) multiple sensory channels, (b) increased sensory fidelity (i.e., sensory feedback mimicking the kinds of feedback we receive in real life), and (c) the increased saturation of sensory channels under what Biocca (1997) terms the *progressive embodiment thesis*. Progressive embodiment theorists place a premium on the ability of new technologies to provide realistic sensory feedback via "advanced communication interfaces" (Biocca, 1997, p. 14). However, if we are to take the proposal that bodily perception is action-oriented seriously, sensory feedback is crucial only insofar as it allows individuals to communicate motoric actions in virtual space. In other words, in order to instill a phenomenology of "being there" in virtual reality it is not enough that sensory feedback mimic non-virtual conditions. Short of fleeting illusory experiences (such as the rubber hand illusion), the best way to instill a sense of presence in VR is to realize that even the virtual body remains a "body for action" (Merleau-Ponty, 2005, p. 96). Moving forward, theorists and researchers of virtual space should focus less on the amount and quality of sensory feedback provided by new technologies and, instead, study how this feedback may be used to author virtual motoric action.

What is more, increased motor planning in virtual space may actually reduce motion sickness and nausea—two of the chief hypothesized barriers to "being there" (Biocca, 1992b, 1997; LaViola, 2000). Perceptual adaptation to new stimuli or unusual feedback is thus possible as long as the subject is allowed to engage in intentional bodily action. Even in cases when perceptual adaptation may result in mistaken perception (as in the case of optical illusions) the body is still able to engage in accurate motor planning. This seemingly impossible condition, in which an individual consciously misjudges objects in the visual field but is still able to accurately navigate an environment, highlights motor planning and conscious perception as two distinct processes. Although common sense implies that what we see and perceive dictates the actions we take, the *dual-systems hypothesis* of vision locates the impetus for bodily action in a host of unconscious processes immune to perceptual distortions (Clark, 2001, 2007, 2009; Goodale, 2008; Milner & Goodale, 2008). For example, based on studies of the visual processing capacities of monkeys, Ungerleider and Mishkin (1982) identify two distinct streams of visual processing: (a) the *ventral stream* tasked with identifying objects and (b) the *dorsal stream* tasked with providing an accurate location of objects through spatial vision (Goodale, 2008). As Clarke (2009) notes, the existence of these "what" and "where" streams contribute in specific ways to perceived aspects of the visual world.

It is upon this dual systems framework then, that Milner and Goodale (1995) introduce their distinction between *vision-for-perception* and *vision-for-action*. Regarding vision-for-action, the dorsal stream provides real-time information about the moment-to-moment location of objects needed for rapid goal-oriented movements such as reaching and grasping. In contrast, vision-for-perception is determined by the ventral stream's ability to generate long-term visual precepts based on projections of the future and stored information from past events. In this capacity, vision-for-perception allows for the conscious recognition and selection of appropriate responses that are then passed on to the dorsal stream to create motoric action (Clarke 2007; Goodale, 2008).

Although vision-for-perception influences the dorsal stream, Goodale (2008) asserts the primacy of *action* to *thinking* in terms of dual visual theories: "But thinking has always been an accessory to action; it is the action, not the thought, that counts" (p. 1). For Goodale then, the comparative usefulness of the ventral and dorsal streams is best thought of in terms of a tele-assistance analogy. Just as a human provides specific parameters to allow action via a semi-autonomous robot, so does the long-term memory of the ventral stream identify objects and select the type of actions the dorsal stream then translates into "metrically accurate, egocentrically specified forms of world-engaging action" (Clarke 2009, p.1461). The tele-assistance model thus points to an intertwined, but necessarily independent, division of labor between vision-for-action and vision-for-perception.

This division of labor may also be conceptualized in terms of "bottom-up" versus "top-down" processing. As a higher-order process, vision-for-perception essentially acts as an accumulated visual knowledge-base about the world (Goodale, 2008). In contrast, vision-for-action concerns itself with fast, automatic, and metrically accurate responses and exists independent of conscious experience (Clark 2001, 2007). As proof of these two distinct frames, Goodale offers contrasting examples of optic ataxia (incoordination) and the now-famous case studies of patient "DF." When damage is sustained to the dorsal stream (resulting in optic ataxia), patients demonstrate difficulty reaching for targets in space and are unable to use visual information to adopt proper grip scaling, aperture, or rotation of the hand if asked to pick up objects (Goodale 2008). Although these patients can convincingly describe the orientation, size, or shape of objects—thereby suggesting that the ventral stream's vision-for-perception is intact— they are unable to translate this knowledge into appropriate motoric action.

The opposite case is presented in the study of the anonymous patient "DF" who was able to grasp objects and navigate obstacles in space even though her ventral judgments were far from normal (Goodale 2008; Patla & Goodale 1997). In many cases, "DF" could not accurately gauge the size, shape, or orientation of objects in her visual field but was still able to physically manipulate these objects in a normal manner. Taken together, these experimental results suggest that vision-for-action and vision-for-perception are not guided by the same cognitive processes but rather appeal to specialized systems to accomplish disparate tasks. Moreover, as demonstrated by a number of experiments regarding vision-for-action and perception, there is reasonable evidence to believe that visually guided action is unperturbed by optical illusions affecting the ventral system (Clark 2007; Goodale 2008). In many cases, the top-down processing of vision-for-action may prove inaccurate while the more basic bottom-up—or as Clark (2007) terms it "zombie"—processing of the dorsal stream provides the real-time translation of information necessary for quick and accurate action.

What is the import of this research for virtual futurists and scholars of mediated communication technologies? First, the dual systems hypothesis once again reaffirms the difference between passive perception of objects in space and more action-based ways of experiencing phenomena. Applied to the study of "being there" in VR, technologies that activate the dorsal stream's vision-for-action offer a possible way to bypass the optically based nausea and motion sickness of passive VR experiences. Through routine action, the illusionary characteristics of virtual worlds may be truncated by an activation of the dorsal stream. As a result, VR technologists should focus on integrating discrete motoric actions such as walking, reaching, and grasping as potential pathways to "being there." Although progressive-embodiment theorists stress that the key to "being there" is located in increased sensory feedback, the dual systems hypothesis suggests that such feedback is relatively worthless if it is not incorporated into the body image via the dorsal stream. If the virtual experience (and by extension the brain) is geared towards low-level action planning, sensory feedback does not need to perfectly mimic real world conditions. Instead, all that is necessary is that this multisensory feedback confirms anticipated action in the most rudimentary of ways.

5. Conclusion: The Cyborg's Dilemma

Although experimental research has yet to authenticate a sense of "being there" in VR, the future is bright. Based on empirical findings in cognitive science and perceptual psychology, it seems quite possible that we may one day integrate virtual technologies into the body image in ways that produce a phenomenology of "being there." This possibility has led some to invoke the negative implications of such a union:

> *The embodiment advanced in the form of virtual environment technology can be characterized as a form of cyborg coupling. This coupling underscores what I call the* ***cyborg's dilemma****, a kind of Faustian trade off: Choose technological embodiment to amplify the body, but beware that your body schema and identity may adapt to this cyborg form (Biocca, 1997, p. 24, emphasis in original).*

Although Biocca's concerns are well taken, scholarship regarding the mutability of the body image suggests that fears regarding the cyborg's dilemma may be overstated. Yes, it is true that the body image can be augmented by many factors, but studies in perceptual adaptation have shown that, even in the most radical instances, we return to "normal" soon after the experimental stimulus is removed. In one of the earliest cases, George Stratton (1896) designed a perceptual adaptation device that inverted the retinal image via a head-mounted system of mirrors. After donning this device for 21.5 hours, Stratton wrote that, upon removing the glasses, "normal vision was restored instantaneously and without any disturbance in the natural appearance or position of objects" (p. 4).

Stratton's experiments corroborate contemporary research positing the existence of both a *long-term* and *short-term* body image (O'Shaugnessy, 1998). In contrast to short term body images, which are susceptible to change based on the location, affordances, and actions of the body, the content of the long-term body image is marked by relatively fixed content. In this way, concerns regarding the cyborg's dilemma may be mitigated if we consider the possibility that the mutability needed to instill a sense of "being there" in virtual worlds could take place exclusively within the domain of the short-term body image.

Only time will tell if the expansion of new technologies will allow for a robust sense of "being there" in virtual worlds. However, as this paper argues, the development of interactive and realistic virtual worlds will most likely come as a consequence of action-oriented design, allowing individuals to enact supervisory control over the actions of an avatar. To this end, advancements in multisensory feedback devices such as haptic gloves are beneficial only insofar as this feedback is integrated into a virtual body image through motoric action. In contrast, to the Dreyfus's (2000) categorical rejection of total telepresence, "being there" in VR exists as an obtainable goal. In spite of the progressive embodiment hypothesis, which emphasizes increased saturation of sensory channels, further scholarship on the possibility of "being there" in VR should take into consideration the subject's ability to implement action via the dorsal stream. As empirical research has demonstrated, individuals are able to extend a sense of ownership or feel present in situations that provide mediated sensory feedback (such as Minsky's "rubber neck" televisual system). For this reason, future research on the phenomenology of virtual spaces should balance an emphasis on multisensory feedback with existing scholarship on the body image and action-based theories of perception.

References

Armel, K. C., & Ramachandran, V. S. (2003). Projecting sensations to external objects: evidence from skin conductance response. *Proceedings. Biological Sciences*, *270*, 1499–1506.

Bermúdez, J. (2005). The phenomenology of bodily awareness. In D. Smith & A. Thomasson, (Eds.). *Phenomenology and philosophy.* Oxford: Oxford University Press.

Biocca, F. (1992a). Communication within virtual reality: Creating a space for research. *Journal of Communication*, *42*(4), 5-22.

Biocca, F. (1992b). Will simulation sickness slow down the diffusion of virtual environment technology? *Presence 1*(2), 334-43.

Biocca, F. (1997). The cyborg's dilemma: Progressive embodiment in virtual environments. *Journal of Computer-Mediated Communication, 3*(2). Retrieved from http://www.ascusc.org/jcmc/v013/issue2

Briscoe, R. (2014). Spatial content and motoric significance. *Avant 5*(2), 199-218. doi: 10.12849/50202014.0109.009

Cassam, Q. (1997). *Self and world.* Oxford: Oxford University Press.

Clark, A. (1997a). A sense of presence.* *Pragmatics & Cognition 15*(3), 413-433.

Clark, A. (1997b). *Being There: Putting brain, body, and world together again*. Cambridge, MA: MIT Press.

Clark, A. (2001). Visual experience and motor action: Are the bonds too tight? *Philosophical Review*, *110*(4), 495–519.

Clark, A. (2007). What reaching teaches: Conscious control, and the inner zombie. *British Society for the Philosophy of Science 58*, 562-594.

Clark, A. (2015). Embodied prediction. In *Open Mind.* T. Metzinger and J.M. Windt (Eds.). Frankfurt am Main: Mind Group. doi: 10.15502/9783958570115.

Cole, J., Sacks, O. and Waterman, I. (2000). On the immunity principle: a view from a robot. *Trends in Cognitive Sciences*, *4*, 167-8.

de Vignemont, F. (2007). Habeas corpus: The sense of ownership of one’s own body. *Mind & Language, (22)*4, 427-49.

de Vignemont, F. (2015). Bodily awareness. In *The Stanford Encyclopedia of Philosophy*. E. N. Zalta (Ed.). Retrieved from: http://plato.stanford.edu/archives/win2015/entries/bodily-awareness.

Dreyfus, H. (1972). *What computers still can’t do: A critique of artificial reason*. Boston, MA: MIT Press.

Dreyfus, H. (2000). Telepistemology: Descartes’ Last Stand. In *The robot in the garden.* K. Goldberg, (Ed.). Cambridge, MA: MIT Press, 48–64.

Evans, G. (1982). *The varieties of reference.* J. McDowell, (Ed.). Oxford: Oxford University Press.

Ehrsson, H. H., Weich, K., Weiskopf, N., Dolan, R. J., & Passingham, R. E. (2007). Threatening a rubber hand that you feel is yours elicits a cortical anxiety response. *Proceedings of the National Academy of Sciences of the United States of America*, *104*, 9828–9833.

Ehrsson, H. (2012). The concept of body ownership and its relation to multisensory integration. In *The new handbook of multisensory processing*. B. Stein, (Ed.). Cambridge, MA: MIT Press, 775-92.

Farne, A., Ladavas, E. (2000) Dynamic size-change of hand peripersonal space following tool use. *Neuroreport*, *11*, 1645–9.

Gallagher, S. (2005). Dynamic models of body schematic processes. In *Body image and body schema*. H. De Preester & V. Knockaert (Eds.). John Benjamins Publishing Co, 233-50.

Goertz, R. (1982). Fundamentals of general-purpose remote manipulators. *Nucleonics 10*(11): 36–45.

Goodale, M. (2008). Action without perception in human vision. *Cognitive Neuropsychology 1,* 1-29.

Gonzalez, C. L., Ganel, T., Whitwell, R. L., Morrissey, B. F., & Goodale, M. A. (2008). Practice makes perfect, but only with the right hand: Sensitivity to perceptual illusions with awkward grasps decreases with practice in the right but not the left hand. *Neuropsychologia*, 624–631.

Heidegger, M. (1962). *Being and time*. New York: Harper.

Hein, A. (1980). The development of visually-guided behavior. In C.S. Harris (ed.). *Visual Coding and Adaptability*. Hillsdale, N.J: Erlbaum, 207–324.

Hollan, J. & Stornetta, S. (1992). Beyond being there. *Proceedings of the SIGCHI conference on human factors in computing systems 92*, 119-125. doi: 10.1145/142750.142769.

Johnson, M. (1990). *The body in the mind: The bodily basis of meaning, imagination, and reason*. Chicago, IL: University of Chicago Press.

Lakoff, G. & Johnson, M. (1980). *Metaphors we live by.* Chicago: IL: University of Chicago Press.

Lakoff, G. (1990). *Women, fire, and dangerous things: What categories reveal about the mind*. Chicago, IL: University of Chicago Press.

Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind & its challenge to western thought*. New York, NY: Basic Books.

LaViola, J. (2000). A discussion of cybersickness in virtual environments. *ACM SIGCHI Bulletin 32*, 47–56. doi: 10.1145/333329.333344.

Lee, K. M. (2004a). Why presence occurs: Evolutionary psychology, media equation, and presence. *Presence: Teleoperators and Virtual Environments, 13,* 494–505.

Lee, K. M. (2004b). Presence, explicated. *Communication Theory, 14,* 27–50.

Lemish, D. (1982). The rules of viewing television in public places. *Journal of Broadcasting, 26*, 757–781.

Lombard, M. (1995). Direct responses to people on the screen: Television and personal space. *Communication Research, 22*, 288–324.

Lombard, M. & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer Mediated-Communication, 3*(2). Retrieved from http://www.ascusc.org/jcmc/v013/issue2/lombard.html

Longo, M., Schüür, F., Kammers, M., Tsakiris, M., & Haggard., P. (2009). Self awareness and the body image. *Acta Psychologia 132*, 166-72.

Maravita, A., Spence, C., Sergent, C., & Driver, J. (2002). Seeing your own touched hands in a mirror modulates cross-modal interactions. *Psychological Science*, *(13)*4, 350–5.

Maravita, A. & Iriki, A. (2004). Tools for the body (schema). *Trends in Cognitive Sciences*, *8,* 79–86.

Merleau-Ponty, M. (2005). *Phenomenology of perception.* (C. Smith, Trans.). New York, NY: Taylor & Francis.

Milner, D., & Goodale, M. (1995). *The visual brain in action*. Oxford: Oxford University Press.

Minsky, M. (1980). Telepresence. *Omni, 2*, 45–51.

Reeves, B. & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. New York: Cambridge University Press.

Minsky, M. (2010). Telepresence: A manifesto. *IEEE Spectrum.* Retrieved from http://spectrum.ieee.org/robotics/artificial-intelligence/telepresence-a-manifesto

Miyazawa, N., Hayashi, M., Komiya, K., Akiyama, I. (2004). Supernumerary phantom limbs associated with left hemispheric stroke: case report and review of the literature. *Neurosurgery*. *54*(1), 228–31.

Nagel, T. (1974). What is it like to be a bat? *The Philosophical Reivew 83*(4), 435-50.

O'Shaugnessy, B. (1998). Proprioception and the body image. In *The Body and Self.* J. Bermudez, A. Marcel, & N. Eilan, (Eds.). Cambridge, MA: MIT Press, 175-203.

Patla, A. & Goodale, M. A. (1997). Visuomotor trans- formation required for obstacle avoidance during locomotion is unaffected in a patient with visual form agnosia. *NeuroReport*, *8*, 165–168.

Peacocke, C. (1992). *A study of concepts.* Cambridge, MA: MIT Press.

Petkova, V. I., & Ehrsson, H. H. (2009). When right feels left: referral of touch and ownership between the hands. *PLoS One*, *4*, e6933.

Reeves, B., & Nass, C. (1996). *The media equation: How people treat computers, television, and new media like real people and places*. New York: Cambridge University Press.

Slater, M., Perez-Marcos, D., Ehrsson, H., & Sanchez-Vives, M. V. (2009). Inducing illusory ownership of a virtual body. *Frontiers in Human Neuroscience, 3*, 214–20.

Stratton, G. (1896). Some preliminary experiments on vision without inversion of the retinal image. *Psychological Review 3*(6), 611-7. doi:10.1037/h0072918.

Ungerleider, L., & Mishkin, M. (1982). Two cortical visual streams. In D. Ingle, M. Goodale, & R. Mansfield (Eds.), *Analysis of visual behavior* (pp. 549–586). Cambridge, MA: MIT Press.

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

Wilson, R. & Lucia, F. (2011). Embodied cognition, *The Stanford Encyclopedia of Philosophy* Edward N. Zalta (ed.). Retrieved from: http://plato.stanford.edu/archives/fall2011/entries/embodied-cognition/.