Sciencepunk:

The Influence of Informed Science Fiction on Virtual Reality Research

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The roots and lineages of many contemporary technologies are oftentimes concealed by their shiny, polished exteriors. And as their lineages are erased, the biases and worldviews that bore those technologies are also forgotten, and it becomes easy to portray current technologies - as well as the practices and research paradigms that involve them - as entirely modern and novel. Of course, ideas are never quite entirely new. For example, Turner has documented how the rise of the new economy, personal computing and virtual communities drew many of their ideals from the countercultural era, ideals that were shared by the Merry Pranksters and had brought forth events such as the Acid Tests and the Trips Festivals (Turner, 2005). In this chapter, we are interested in the roots of a different kind of "consensual hallucination" (to borrow William Gibson's phrase) - the technology of virtual reality and, in particular, the empirical social science research that revolves around it. In the same vein as Turner, we trace the roots of many current research questions back to influential science fiction novels of the early 80s. We argue that many of the questions that were raised in cyberpunk novels about two decades ago are the research questions that current virtual reality researchers are trying to answer.

Cyberpunk

Cyberpunk's origins are largely attributed to the early work of Vernor Vinge, in the form of a short story called True Names, and William Gibson, specifically the trilogy of *Neuromancer*, *Count Zero*, and *Mona Lisa Overdrive*. Subsequent works by authors such as Bruce Sterling, Rudy Rucker, Neal Stephenson, and more recently Richard Morgan, further cultivated this genre, and certainly one can argue that the earlier work of Philip K. Dick and others offer a solid foundation for these later novels. While critics and writers differ on any formal definition of the genre, key characteristics of cyberpunk

include: a) a dark vision of the future dominated by corporate culture, b) fortified humans whose representations include not just flesh and blood but digital, narcotic, or robotic augmentations, and c) economies driven more by digital information than by physical material.

Virtual Reality Research

Currently, there is no standardized definition of virtual reality that is widely accepted within the field. The term was originally coined by Jaron Lanier, and is currently used widely, and often incorrectly, in a number of contexts. For the purposes of this paper, we define virtual environments as "synthetic sensory information that leads to perceptions of environments and their contents as if they were not synthetic" (Blascovich et al., 2002, pg. 105). Typically, computers are used to generate these images and to enable real-time interaction between a user and the virtual environment. An immersive virtual environment is one that perceptually surrounds the user of the system. Consider a desktop computer video game; playing that game using the arrow keys on a keyboard is a VE. On the other hand, if players were to have special equipment that allowed them to take on the perceptual senses of the main character of the video game, that is, to control that character's movements with their own movements and interact with stereoscopic displays such that they actually felt as if they were inside the video game, then they would be using immersive virtual reality.

Immersive virtual reality must employ two characteristic features by definition. First, the users are unobtrusively tracked as they interact with the digital world. User actions such as head orientation and body position are automatically and continually recorded and the perceptual display (either a head mounted display or a room with

projection screens on all of the walls) is in turn is updated to reflect the changes resulting from these actions. In this way, as a person moves the virtual scene is automatically updated to match the person's movement. Second, sensory information from the physical world is kept to a minimum. By designing the head mounted display or the projection room to block out objects from the physical world, immersive virtual reality allows people to more easily become enveloped by the digital information.

Current VR research proceeds along a number of avenues, including computer scientists developing programs for driving behavior tracking, animations, and artificial mental states, graphic artists designing three-dimensional modeling and texturing techniques, engineers focusing on hardware, medical researchers developing simulations to train surgeons, military personnel designing training simulations for soldiers, clinical therapists developing virtual desensitization simulations to treat phobias, and social scientists examining the human experience within computer-mediated communication. Loosely speaking, experiences that qualify as "virtual" range from sending an email to playing video games to wearing fully immersive, stereoscopic displays that track and render user movements.

Overlapping Social Networks

The world of cyberpunk authors and the world of virtual reality researchers have always been intimately interwoven. First of all, well-known virtual reality researchers collaborate with influential cyberpunk authors. For this project, we conducted informal interviews with two major figures in the field of virtual reality. Jaron Lanier is the pioneer who coined the term "virtual reality" in the early 80s as well as developed the first immersive simulation in which multiple avatars could interact. In the interview,

Lanier talked about collaborations with Gibson. Another well-known researcher, Thad Starner, was also interviewed. Starner is a professor at Georgia Tech who has been a cyborg (i.e., has a laptop with translucent heads-up display goggles) for over a decade. Over the years, Starner has been in regular contact with Verner Vinge to discuss ideas.

And secondly, cyberpunk texts are treated as serious academic texts in virtual reality courses and research. Not only are *Neuromancer* and *Snow Crash* widely read by current virtual reality researchers, these early cyberpunk texts are required reading in formal classes on virtual reality and digital human interaction. For example, a quick Google search of "Neuromancer" and "syllabus" will produce several pages of such courses. Moreover, Vinge, Gibson, and Bruce Sterling (author of *Mirrorshades: The Cyberpunk Anthology*, an influential collection of short stories) often speak at academic conferences on engineering, technology, and on virtual reality. In 1994 Bruce Sterling gave the Keynote Address at SIGGRAPH, the premier conference on computer graphics (Sterling, 2004).

The Influence of Cyberpunk on Virtual Reality Research

In the current paper, we examine how themes developed by cyberpunk science fiction writers have shaped the paradigms in which virtual reality researchers operate. We focus on four works in particular: William Gibson's *Neuromancer*, Vernor Vinge's *True Names*, Neal Stephenson's *Snow Crash*, and Rudy Rucker's *Software.* Within each of these works, we examine specific constructs, and demonstrate that the research agendas chosen by scientists, both methodological and theoretical, as well as the specific hypotheses tested within those agendas, are either implicitly or explicitly shaped by earlier works of science fiction. This relationship is not surprising, considering that

cyberpunk authors often have extensive science backgrounds and explicitly communicate with virtual reality technologists. However, the degree to which scientists rely on constructs developed by fiction writers (who possess only a small fraction of scientists' expertise), is quite large. The current work explicates this relationship. We also highlight how different visions of cyberpunk virtual reality are being constructed and tested in VR research and how these tensions were foreshadowed by cyberpunk fiction.

A Hierarchy of Being

Neal Stephenson, the author of *Snow Crash*, is largely credited with applying the term *avatar* onto digital human representations in the mid-nineties. Avatar is a religious term, which is typically defined as the incarnation of a deity. In other words, the gods of Eastern religions could not visit the Earth without embodying some type of recognizable human or animal form. Similarly, when humans visit digital space, they need to have some type of vehicle to carry their intentions and actions; Stephenson refers to this form as an avatar.

Some would argue that the major contribution of Stephenson was to thoroughly explore the vast possibilities of avatar taxonomy. In the *Metaverse* (Stephenson's term for cyberspace), real people use avatars to interact with other people in the virtual world. These avatars can vary drastically in terms of realism, in that Avatars created by programmers can be perfect analogs of the user in terms of their appearances and gestures, or alternatively users can purchase "off-the-shelf" avatars, stock bodies that widely populate the Metaverse as well. Some people also choose to render themselves unrealistically in completely nonhuman form. According to Stephenson, "Your avatar can look any way you want it to, up to the limitations of your equipment. If you're ugly,

you can make your avatar beautiful. If you've just gotten out of bed, your avatar can still be wearing beautiful clothes and professionally applied makeup. You can look like a gorilla or a dragon or a giant talking penis in the Metaverse. Spend five minutes walking down the street and you will see all of these" (pg. 25).

Yet even as Stephenson describes this representational plasticity, there is an inherent tension between Metaverse reality and real-life reality in *Snow Crash*. Consider the detail that the protagonist, Hiro, has an avatar that "just looks like Hiro, with the difference that no matter what Hiro is wearing in Reality, his avatar always wears a black leather kimono" (pg. 26). Stephenson also describes Juanita in great detail, emphasizing her veridicality, "with no effort made to hide the early suggestions of crow's feet at the corners of her big black eyes. Her glossy hair is so well resolved that Hiro can see individual strands refracting the light into tiny rainbows" (pg. 185). The Metaverse is also a place where businessmen around the world come to negotiate as well as a place where real-life lovers come on dates. Thus, even as he hints at the endless possibilities of existence, the Metaverse that Stephenson creates is very much meant to be a reproduction, an extension, of reality. It is a place to be yourself and conduct your real-life business and affairs.

More importantly, the goal of the Metaverse is to replicate reality in its full detail - visually and behaviorally. The insistence is on creating avatars that look photorealistic and having them move in convincing ways. And Stephenson introduces a hierarchy of realism. Avatars are not created equally; some are more photorealistic and behaviorally-realistic than others. In other words, variation in skill and disposable income produces this hierarchy of being in the Metaverse.

This obsession with realism and equipment quality produces a unique vision of what virtual reality is supposed to be - a vision that emphasizes reproduction of reality. That vision prompts a certain set of research questions. The idea of avatar realism (how high in fidelity an avatar is) and avatar anthropomorphism (how much an avatar looks like a human being, as opposed to other living or nonliving things), has received quite a bit of attention in the literature on virtual reality. One of the only developed process models that attempts to model the interaction between humans and virtual humans, developed largely by social psychologist Jim Blascovich (Blascovich, 2002; Blascovich et al., 2002), focuses on these dimensions of realism and human agency. According to that model, there is a tradeoff between behavioral realism (the degree to which human representations behave as they would in the physical world) and perceived agency (the extent to which the interactants thinks they are interacting with another actual human being). The higher the realism, particularly communicative realism (e.g., facial expressions), the less perceived agency needed to achieve social influence and effective interaction. Hence, according to the model, social influence and effective communication with virtual humans is likely to occur when either realism or agency are high, or both.

While the social influence model of virtual interaction is probably the most thorough framework for evaluating social interaction, the notion of avatar realism has received a large amount of attention from the virtual reality community for a number of years. Indeed, an engineer credited with one of the most influential books on building virtual human personality (*Simulating Humans* by Badler, Phillips, & Webber, 1993), Norman Badler, was a coauthor on a paper at a major virtual reality conference in 1998 titled “Avatars a la Snow Crash”. In that work, he surveyed the field in terms of how

realistic current avatars were across the world in various virtual reality labs. He compared current avatars at the time to what he considered the "gold standard" of avatars, namely how real the avatars were in Stephenson's 1992 novel:

> In summary, we believe that communications bandwidth and graphics rendering speed are the primary current limitations to Snow Crash scene complexity and number of avatars. Other aspects of Snow Crash avatar design, motion, and appearance offer no challenges that are unmet in the research literature. The major gaps seem to lie in the control transformation from the user's desires to the avatar's actions and in the modification of an animated action based on the attitude, personality, and reactions of the live participant. (pg. 4)

Since then, within the field of communication, the pioneers of examining virtual humans, mediated humans, and virtual reality have all been focusing on this question of avatar realism (Badler et al., 1993; Bailenson, Beall., Blascovich, Loomis, & Turk, 2005; Benford, Bowers, Fahlen, Greenhalgh, & Snowdon, 1995; Biocca & Levy, 1995; Blascovich et al., 2002; Cassell & Vilhjalmsson, 1999; Lombard & Ditton, 1997; Slater et al., 2000; Thalmann & Thalmann, 1999). These researchers typically have a human interact with some type of a virtual human and explore a number of dimensions of realism.

Some of this emphasis on realism traces its roots back to Stephenson's vision of the Metaverse, and Stephenson's vision itself has become the benchmark for what good virtual reality is. Ironically, this particular problem is difficult to solve. Avatars can resemble their human counterparts along a number of dimensions (see Blascovich et al., 2002 for an overview); the two which have received the most attention in the literature is behavioral resemblance (number of a given human's behaviors the avatar exhibits) and photographic resemblance (how many of a given human's static visual features the avatar

possesses). The degree of behavioral resemblance is largely governed by the ability of the system to track behavior (know exactly what the human is doing at every given moment), and then to render behavior (transpose that exact behavior onto the digital representation).

Currently, real-time behavioral tracking technology for avatars, while improving steadily, is extremely far from matching expectations instilled by popular culture, for example, online representations of characters from *The Matrix*. In those fictional accounts, the movements and gestures of avatars are seamless; the actions of human and avatar are perceptually indistinguishable. Outside the fictional realm, however, real-time behavior tracking is extremely difficult. While there have been advances in tracking of gesture through various forms mechanical, optical, and other systems (see Turk & Kolsch, 2003 for a review), the gap between actual movements and real-time tracked movements remains large.

Furthermore, once the movements and behaviors have been captured, they need to be rendered onto the digital representation of the avatar. This process is not trivial, and many issues arise in terms of the quality of the movements and behaviors when applied to a digital model that contains fewer degrees of motion freedom than the human body does. In other words, currently digital models simply don't have enough joints to support completely naturalistic and realistic movements. While the advances in motion capture rendering and inverse kinematics have been quite good with non-real-time representations (see any film by Pixar), the same is not true with real-time avatars in which these motions need to be expressed on the fly.

On the other hand, there are fewer barriers to achieving high photographic resemblance. The use of three-dimensional scanners, as well as photogrammetric

software allows for the realistic recreation of static, digital human heads and faces that are nearly real enough to function as an analog to a real face (Bailenson, Blascovich, Beall, & Loomis, 2003). The key challenge, though, is designing faces and bodies in high enough detail to allow for the realistic rendering of behavior described above. In sum, with current technology, static avatars currently can look quite a bit like their human controllers; however, avatars can only perform a small subset of their controllers' actions in real-time. The standard for realistic avatars, which some researchers believe has been set by the fictional work of *Snow Crash*, is constantly being examined by virtual reality scholars. While the idea of realism in virtual humans and robots was obviously discussed prior to this novel (see Mori's 1982 discussion of the *uncanny valley*), the proliferation of this construct accelerated after the popularization of *Snow Crash*.

Being There

Tied to this urgency of creating more realistic avatars is the notion of *presence*, the degree to which the user actually feels as if he or she is present in the virtual reality (as opposed to present in the physical world). Indeed, the premiere journal dedicated to virtual reality research is called PRESENCE, and a wealth of research seeks to understand the phenomenon of presence: understanding the mechanisms that underlie the subjective experience of "being in another world" strikes at the very heart of the virtual reality experience. To this end, when building a virtual reality simulation, there is often a desire to digitally recreate as realistic an analog of the physical world as possible. In other words, if two people enter a virtual conference, then one way to achieve high presence is to render each virtual person to look and behave exactly like the physical

person that virtual person represents. A large number of researchers within the virtual reality work within this paradigm, building more and more sophisticated sensors and equipment to replicate physical reality as faithfully as possible in the virtual environment.

Vernor Vinge's short story "True Names", while probably less commercially successful than *Neuromancer* or *Snow Crash*, predates both those novels (written in 1979, published in 1981) and may have been had the most influence on virtual reality researchers of the three. As evidence for the importance of Vinge's work, an edited collection entitled *True Names and the Opening of the Cyberspace Frontier* (Frenkel, 2001) features articles written by a number of scientific virtual reality developers and researchers.

Vinge defined the "Other Plane" as a digital world accessed by attaching electrodes to one's head. Inside the digital world are representations of other people (i.e., avatars), intelligent embodied agents, and large data structures as well as digital structures such as landscapes, castles etc. In his short stories, Vinge explores many of the concepts that have become central to many scientific research programs. In sum, "True Names" is largely considered the first piece of science fiction to really explore the constructs and parameters of a world in which everything and everyone one is digital. While there are indeed some other works that predate this book and peripherally explore the idea of avatars, (see, for example, "The Girl Who Was Plugged In" by James Tiptree, Jr. written in 1969 for a rough depiction of biological, non-digital avatars), Vinge was the first to truly explore the space of a world in which digital representations were pervasive.

One notion of Vinge's that has influenced the paradigm of virtual reality research is this notion of presence, how immersed one is in virtual reality, as opposed to the

physical world. Researchers across the discipline predominantly treat the concept of presence as a subjective, psychological construct, as opposed to a construct based on technology. In other words, according to a majority of researchers in the field, the experience of immersion is independent of technology-it is possible to feel higher presence in a well done film or novel than in a poorly constructed virtual reality simulation. This notion was central to the manner in which Vinge described the other plane: "He powered up his processors, settled back in his favorite chair, and carefully attached the Portal's five sucker electrodes to his scalp. For long minutes nothing happened: a certain amount of self denial-or at least self hypnosis-was necessary to make the assent" (pg. 250). In other words, entering into the digital simulation was not merely perceptual, but psychological as well. This concept is demonstrated repeatedly in presence research (see Biocca, Harms, & Burgoon, 2003 for a review).

Of course, the problems of avatar realism and presence are themselves rooted in a particular vision of what virtual reality is supposed to accomplish. And it is this assumption that creates the set of research questions that seem meaningful to ask. But should reality (or its absence) be the yardstick of virtual reality? And what other questions could we be asking if we didn't insist on replication, veridicality, and escapism?

Superhuman Powers

Cyberpunk offers an alternative vision of virtual reality, one where its primary goal is not reproduction but augmentation and transformation. In *Neuromancer*, William Gibson hints at many of these possibilities. Gibson is credited with inventing the term cyberspace, though there are some works published a few years earlier which do begin to develop the general concept of cyberspace. Gibson defines cyberspace as "A consensual

hallucination experienced daily by billions of legitimate operators, in every nation, by children being taught mathematical concepts … a graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity" (pg. 51). Gibson's influence is pervasive in actual scientific research about virtual reality because his writing explored so thoroughly the possibilities of digital humans interacting within digital space. A quick "Google Scholar" search indicates that *Neuromancer* has been referenced by over 150 science articles in refereed journals; this frequency of citation is about seventy-five times higher than the average science paper which actually conducts empirical research or technological development within virtual reality.

In the fictional world crafted by Gibson, human identity, appearance, and behavior, while in either cyberspace or in physical space, has an extremely high degree of plasticity. Through digital algorithms, biological and genetic augmentation, and mechanical devices, the human experience is mutable. Despite having the technology to render virtual simulations and physical bodies to be completely realistic, people choose to abandon close ties with their genetic blueprints and instead opt for transformed representations.

For example, a major character named Molly has augmented her body to give her digital readouts of the world around her not possible in the physical world. Special implants provide her with the ability to see in the dark, access data from cyberspace, and to communicate via text with other people. This type of augmented ability using digital information is quite common now across many types of science research. Government funding agencies issued a major push in the late 1990s with a research agenda called

Augmented Cognition (see Schmorrow & Kruse, 2004 for a detailed history), designing computer interfaces to extend the limitations of normal human cognition. One major rationale for this work was to provide digital wearable displays that could increase the working memory of people by allowing them to be able store cognitive information on displays as opposed to having to keep them actively stored in memory. Similarly, VR research is providing augmentations of social sensory abilities. These transformations compliment human abilities to draw inferences about the social world. Because everyone in a virtual reality simulation is digital, people can use algorithms to interpret the social actions of other people around them. For example, in addition to being able to survey a crowd of fifty students with her eyes and ears, a teacher in virtual reality can receive real-time summary information across her visual field about how often each student is smiling, nodding, looking away, talking, etc—a speaker can receive extremely helpful and detailed information at the micro level for each individual. Moreover, this information can be supplied to the self - the teacher can also receive automatic registers that ensure she is spreading her attention equally towards each student.

A similar notion of transformed social abilities raised by Gibson is his depiction of simstim. Simstim is when one person receives all of the perceptual information from another in real-time. In other words, sensors in one person record all of the stimuli being experienced from one person, send it over a network to a second person, and the second person experiences the world of the first person across all five senses in real-time. Researchers are currently using this type of simulation. For example, Steve Mann, a professor in Electrical Engineering at the University of Toronto, wore a special pair of glasses that had a webcam on them whenever he ventured outdoors for extended periods

of time. He then could play the feed of the webcam to a dedicated website, so that other people could tune in and experience perceptually exactly what it was he was seeing and hearing, with the idea of creating a system in which it was more difficult for people to be persecuted and victimized if their line of sight could be taken on by uncountable amounts of watchdogs on the Internet. In sum, by increasing the amount of wearable computers, accountability of society would be increased. This notion is directly related to Gibson's vision of simstim.

In terms of augmented interactions, we have been implementing a number of experimental simulations in which one person is forced to take the point of view of another person. As X and Y are interacting, X can take Y's visual point of view, and then see himself, in real-time, from Y's point of view. In other words, imagine that another person was wearing a small video camera right between their eyes, and the video feed went right into your own eyes as they were looking at you in a conversation. We have been examining the possibility that people will act in a more cooperative fashion when forced take the point of view of others, and have implemented this in two contexts, a negotiation context in which people reach mutually beneficial solutions when adapting one another's field of view, as well as a diversity simulation context in which we examine the effect on empathy responses of taking on an identity of someone of a different race, gender, or age.

Transformed Social Interaction

Beyond super-sensory abilities, virtual reality offers a large degree of representational and behavioral plasticity. In *Software*, Rudy Rucker offers a true gem of the potential of this plasticity. Towards the end of the novel, Cobb Anderson has been

given a highly advanced robotic body and has been given the task of creating a cult. To achieve this goal, Cobb gains the utter devotion of initiates by taking them individually into a room and changing his facial structure to match that of the initiate's. In other words, Rucker is hinting at the possibilities of using representation plasticity for social advantage. What is even more striking is that Rucker shows the possibility of representational plasticity without a virtual reality construct. Rucker's world is digitized via the large presence of robots instead of a virtual environment.

This notion of plasticity has profound implications. In virtual reality simulations, the world is constantly being redrawn separately for each user simultaneously. Consequently, it is possible to break the normal physics of conversation and to render the interaction differently for each user at the same time. In other words, in virtual reality, each user can theoretically alter their stream of information in real time for strategic purposes, such that what other people in VR see is not their actual appearance or behavior, but instead the appearance and behaviors that they would like others to see. The theory of Transformed Social Interaction (Bailenson, Beall, Loomis, Blascovich, & Turk, 2004) examines the possibilities that these real-time transformations raise. People who subscribe to this paradigm believe that it is possible to achieve higher levels of presence when reality is augmented or transformed than when reality acts as an immutable constraint on the simulation. In other words, users may more effectively achieve their goals while interacting in virtual reality (e.g., goals such as entertainment, social relations, or commerce), if they strategically alter the virtual world around them, including perhaps breaking the constraints of their own faces, bodies, and behaviors.

In this alternative vision of virtual reality as transformed reality, where virtual selves are not meant to be extensions or reproductions of the real self, what Gibson (1999) referred to as "the infinite plasticity of the digital" (pg. 117) is foregrounded. Vinge also embraces the notion of transforming the representation of the self (i.e., transformed social interaction). "Robin Hood, dressed in green and looking like Errol Flynn, sat across the hall in a very close conversation with a remarkably good-looking female (but then they could all be remarkably good looking here) who seemed unsure whether to project blonde or brunette" (pg. 255). According to Vinge, the Other Plane was particularly attractive to those who felt a need to abandon their physical representation: "And then, since the beginning of time, there had been the people who simply did not like reality, who wanted another world, and if given half a chance would live there forever … never moving, never exercising their real world bodies" (pg. 321). This concept of projecting a digital self that is drastically different from the physical self is explored rigorously in the work of Vinge, and this concept is quite prominent in current VR research.

Researchers studying transformed social interaction have begun to explore the effects of digitally changing identity. Current digital technologies are allowing us to dramatically alter our self-representations with the click of a button in a way that was never possible before. Nowhere is self-representation more flexible than in virtual environments where users can choose or customize their own avatar (digital representations of themselves). In many online video games, users can adjust their gender, height, weight, skin tone, eye shape, eye color, hair style, hair color, nose prominence, lip fullness, and facial structure, and can adjust these variables whenever they would like at

the click of a button. Every day, millions of users in these online environments interact with each other via avatars of their own choosing (Woodcock, 2005; Yee, in press).

Transformed Social Interaction research has proceeded along two lines examining self representation. The first line examines the effectiveness of such a strategy in terms of social influence—does changing the attractiveness, gender, race, facial structure etc. of your representation make the individual more effective at achieving different goals of social influence? As such, we have examined the implications of making your avatar's facial structure more similar to someone else (Bailenson, Garland, Iyengar, & Yee, in press), use of automatic nonverbal mimicry of someone else in one's avatar (Bailenson & Yee, 2005), augmented gaze, that is, being able to look directly into the eyes of more than one person at once (Bailenson et al., 2005), and other transformations. All of these empirical studies indicate that transformations of identity are difficult for any given audience to detect, but quite effective at persuading that audience.

The second line of studies examining transformations to self representation examines what effect these transformations have on a person who implements them. In other words, how does wearing a beautiful or tall avatar change the behavior of a user who may be neither beautiful nor tall? We have demonstrated that an individual's behavior conforms to stereotypes of their self-representation - a process we term "the Proteus Effect" (Yee, Bailenson, Ducheneaut, Moore, & Nickell, 2005). We argue that just as men and women conform to gender roles (i.e., *social role theory*, Eagly & Wood, 1999) and just as the elderly conform to expected age stereotypes (i.e., *self-stereotyping*, Levy, 1996), we have demonstrated that people conform to stereotypical behaviors associated with their digital self-representations.

In a series of experiments, Yee and colleagues tested the Proteus Effect by having subjects look in a virtual mirror, and notice that their avatar was either particularly high (or low) in either height or attractiveness. We have demonstrated that, regardless of how tall or beautiful our subjects were, subjects who were virtually beautiful were more likely (compared to control conditions) to walk within another person's intimate space and to reveal more information about themselves to another person. Furthermore, virtually tall subjects negotiated more successfully in a money splitting task than virtually short subjects. In sum, changing the self not only changes your ability to influence another person, it changes the way the user acts on some of the most basic levels of social interaction.

Immortality

A final influence of science fiction on virtual research combines both elements of reproduction and transformation - the notion that virtual reality confers some form of immortality. We see variations of this theme in several of the cyberpunk novels we've mentioned, centered on the idea that our personalities and identities can be captured via software. In *True Names*, Erytrina proclaims as she dies that "My kernel is out here in the System. Every time I'm there, I transfer a little more of myself. The kernel is growing into a true Erytrina, who is also truly me. When this body dies, *I* will still be, and you can still talk to me" (pg. 329). In *Neuromancer*, the construct known as Dixie Flatline is a software replicate of a renowned hacker's personality and expertise.

Rucker pushes this idea the furthest in *Software*. In that novel, robots and humans are living in uneasy co-existence. The more advanced robots have invented a way of preserving a person's memories, personalities, and expertise. The robots see this as a way

to create a global consciousness - a form of higher life. The only side-effect of the procedure is that the entire brain is destroyed in the process. On the other hand, digitized identities can then be stored in a variety of human-form robots that will never die. This is the version of immortality that the protagonist, Cobb Anderson, achieves.

Researchers have been actively exploring this concept. For example, William Bainbridge, currently a program officer at the National Science Foundation, runs the personality capture project, in which digital technology is used to archive the "true essence" of a person, including physical descriptors, biographical information, and personality dimensions. Bainbridge (Bainbridge, 2003) has developed an extremely extensive archive:

> Contemporary information technology facilitates the creation and administration of much longer questionnaires than traditionally was feasible, and people may be motivated to respond to them as a means of capturing significant aspects of their personalities. This can be useful in designing *sociable technology* - computer avatars, software agents, and robots with simulated personalities - and in creating personality archives for research or memorial purposes. This article illustrates how *personality capture* can be accomplished through 20,000 questionnaire items culled from responses to open-ended online questions, content analysis of existing verbal or textual material, and using words from dictionaries, encyclopedias, and thesauri. This approach enables detailed idiographic study of a single individual, based on fresh measurement items and scales derived from the ambient culture. (pg. 21)

Rucker describes this version of personhood and immortality more succinctly - "the soul is the software" (pg. 66).

Conclusion

When John Barlow first experienced immersive virtual reality, he immediately saw the connection between this "consensual hallucination" provided by digital technology and the consensual hallucination provided by a very different pharmaceutical

technology. He likens the VR experience to getting high and “psychedelic”. What struck Barlow the most was the disembodied experience provided by early VR. He compares the liberation to an expression of a primal human desire - the “desire to have visions”. Of course, what is most ironic is that virtual reality research has always insisted on embodiment. The disembodied experience provided by early VR was due to unavailable technologies rather than actual intention.

Barlow’s vision of what virtual reality was supposed to be was very different from the ones that had been adopted by the community of virtual reality researchers. On one front are visions of virtual reality as reproduced reality where realism and presence are the core research themes. On another front are visions of virtual reality as transformed reality where notions of representational and behavioral plasticity are the core research themes. In between is the notion of immortality. The commonality is that all these different threads of research find their roots in cyberpunk novels written two decades ago. Barlow’s vision does challenge one shared assumption among current virtual reality research—why do we insist on embodiment in virtual reality? And indeed, what virtual worlds could we create if we didn’t have to worry about how real our bodies and faces looked?

Determining the direction of the causal arrow is a tricky endeavor when examining historical patterns. To claim that science fiction has shaped the research paradigm of virtual reality research is likely an overly bold claim which is impossible to either prove or falsify. However, it is certainly clear that a number of researchers have used these cyberpunk texts as a source for research questions as well as for a standard for evaluating the efficacy of state of the art virtual reality simulations. What makes these

texts a useful resource is not their description of technology, but instead, their exploration of world in which information and people are represented thoroughly in digital space. Authors like William Gibson, Bruce Sterling, Neal Stephenson, and Vernor Vinge are influential not because they have a solid grasp of digital technology, but instead because they possessed the insight to see the inevitable changes in the social world that occur when digitally mediated interaction becomes the predominant form of social activity, and to explore the possibilities of that world to its fullest.

In sum, scientists brainstorm important research questions as new technologies arise to support those questions. However, the cyberpunk authors, not limited by the existence of the actual technology, have stipulated the existence of the enabling technology and proceeded to explore the implications for people in those fictional worlds. As we move closer to achieving technologically the worlds depicted in cyberpunk, scientists can provide new research *answers* concerning the use of the technology, but will have more difficulty in creating new research *questions*, as many these questions have largely been exhausted in fiction.

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