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AVATARS

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Avatars, a word once uttered by only hardcore gamers and science fiction fans, have begun to make their way into living rooms across the world. Their infiltration into our everyday lives has grown from a subtle trend to a suddenly marked phenomenon. Avatars appear as virtual sales associates that assist consumers on websites and as feature realistic digital representations that move in sync with the players' movements in console video games, such as Microsoft's Kinect or Nintendo's Wii. Online worlds, massively multiplayer online role playing games (MMOs), and video games, are quickly becoming one of the most popular forms of media entertainment.

As reported on the Game Daily website April 3, 2008, video games have grown into a $26.5 billion industry worldwide, nearly surpassing the global film industry at $26.7 billion. Also, a 2010 report from the Kaiser Family Foundation, titled *Generation M2*, revealed that a child between the ages of 8 and 18 spends an average of nearly 1.5 hours at a computer and 1.25 hours playing video games every day. In the popular media, James Cameron's award-winning film *Avatar* has uniquely accelerated the consumer market for three-dimensional television and popularized the idea of self incarnation through technology to the masses. Considering the speed of public exposure to avatars and technical developments, it is likely that avatars will become increasingly widespread and influential in time. In this light, a close examination of how human psychology and behaviors are affected by interactions with avatars is in order.

Despite the public excitement, formal scientific investigation on these digital

representations is a relatively nascent field which has mostly developed in the past decade. The bulk of the research has been led by two research areas. The first group consisted of social scientists who observed and measured the psychophysiological and behavioral responses of humans. The second group consisted of computer scientists interested in creating avatars that mimic human emotions, cognitions, and behaviors. These scholars come from vastly different fields, but through rigorous work in this new area, they encouraged other researchers in related disciplines to become active within the field of avatar research.

This chapter will focus on two individual scientists who are viewed as leaders in the field of avatar research. While there are dozens of scientists who fit the general description of leaders studying avatars, the two we have chosen epitomize the pioneering, interdisciplinary work that has propelled avatar research into the mainstream. Before introducing the leaders, some background information on avatars is presented to help understand the degree of impact that the leaders have had on the field of avatar research.

Defining Avatars

The word “avatar” originates from the Sanskrit word *avatara*, meaning “descent,” to describe an incarnation or a bodily manifestation of an immortal being in Hinduism. Hindu deities are believed to come to Earth as avatars to help humans in their struggle toward enlightenment and salvation. With the advent of the era of information and technology, it is not completely clear as to how the word trickled into popular usage, but it is commonly attributed to Neal Stephenson’s 1992 science fiction novel, *Snow Crash*. In this novel, users of a computer-based system are able to enter virtual worlds and interact with virtual versions of one another, referred to as “avatars.”

Broadly defined, any form of representation that marks a user’s entity can be considered an *avatar*. A name, a voice, a photo, a top hat used in Monopoly: these can all serve as a user’s avatar although they may not look or behave like the user (Bailenson et al 2008). Different traits such as the degree of form realism (i.e., how the avatar looks like a human user) and behavioral realism (i.e., how the avatar behaves like a human user) influences how another person perceives and responds to an avatar (Blascovich et al 2002).

In the past, avatars typically served as mere visual markers of users (i.e., icons with limited movement), while much of the actual interaction in digital environments relied on textual communication (Taylor 2002). Although avatars sometimes resembled human figures, they were blocky and primitive in form, rendered with coarse graphics. Also, individual customization was limited to simple options such as changing the color of clothing and selecting the sex of the avatar.

Over time, avatars have become more complex creations, rendered in three-dimensional forms with an extensive range of animated movements that aid in the expression of the avatar's personality and supplement various social interactions. Options for individual customization of avatars have increased significantly as well, allowing users to modify a number of physical features including eye color, hair style, height, body shape, clothing, and even facial expressions. Using these diverse features, users have great freedom to build not just a graphical marker of themselves, but *virtual humans* with distinctive personalities, unique appearances, and individualized behavioral patterns. Although perhaps not yet as elaborate as the futuristic world depicted in *Snow Crash*, technological advancements have allowed users to build relatively sophisticated virtual communities, carrying out social activities using their self-representative avatars. These avatars move and communicate as their owners' (i.e., users') digital surrogates to interact, work together to defeat a common foe, build norms and rituals, and develop a unique culture of their own, presenting rich potentials for research (Bainbridge 2007).

Although both a small dot on a screen or a lion-headed beast that users control in a video game may be considered an avatar, past and current scientific investigation on avatars has been heavily focused on avatars in human form. Therefore, this chapter will focus the discussion on *virtual humans*, which are avatars that look like humans: of bipedal form with typical human faces and features. In the following sections, we will examine the progress of virtual human research and learn how leaders from different fields envisage a future in which much social interaction occurs through virtual humans.

Case Study 1—Social Science Meets Immersive Virtual Environments

Social scientists have struggled between the costs and benefits of experimental control and ecological validity since the introduction of experimentation in social science. For

example, observing someone's behavior while sitting in a crowded cafeteria offers ecological validity in the sense that the subject is situated in her natural environment, but the scientist cannot control the actions of all the other people in the cafeteria. On the other hand, in the laboratory the scientist can control the environment completely, but in turn may make the experience sterile, preventing real, natural behaviors from emerging. Researchers have had to choose between the power to parse out different variables and the ability to observe and measure natural thoughts, feelings, and behaviors of participants. At the University of California, Santa Barbara, some innovative academics in the Department of Psychology considered how novel virtual technologies could be used in laboratory experiments to optimize ecological validity without compromising experimental control.

Using Virtual Humans to Study Social Interaction

Jack Loomis and his student Andy Beall first introduced *immersive virtual environments* (IVEs) as a research tool in the late 1980s, conducting studies on perception and spatial cognition. IVEs are virtual environments that present rich layers of synthesized sensory cues to the user so that the user feels enveloped by the mediated environment and is willing to believe that the environment is real (Witmer and Singer 1998). Social psychologist Jim Blascovich joined the faculty at UCSB and began working with Loomis and Beall in the late 1990s. Together the group explored the incorporation of virtual humans within IVEs to examine the possibility of using virtual reality technology as a research tool to answer social scientific questions (Loomis, Blascovich, and Beall 1999). Andy Beall subsequently founded WorldViz LLC, a company at the forefront of the development of IVE technologies, and became an assistant research professor at UCSB. Currently, Blascovich and Beall are co-directors of the Research Center for Virtual Environments and Behavior at UCSB.

Blascovich et al (2002) argued several advantages to using IVEs in social science studies. First, IVEs allow the researcher to create experimental situations with more mundane realism compared to the rigidly controlled laboratory settings, eliciting more genuine participant reactions to the stimuli. For example, rather than invoking fear by asking participants to imagine standing at the edge of a precipice or giving them a written passage describing the scenario, IVEs allow participants to perceptually experience that

situation by providing immediate and realistic sensory cues (e.g., see the precipice in front of them). Additionally, IVEs can be used to create a variety of naturalistic environments (e.g., a shopping mall, a doctor's office, a movie theater, or an airplane cabin) in a controlled manner, thus providing the advantage of being able to study occurrences in these places without interference from other cues that might disrupt studies in corresponding real world environments, such as the smell of food or ringing of cell phones. In the same vein, IVEs can be used to create stimuli that are unavailable or difficult to manage in the real world, such as large crowds, snakes, or children.

The development of IVEs has led to even further advancements of virtual human representations. Using computer software that accurately models the user's physical features and devices that closely track the user's physical movements, photorealistic three-dimensional avatars that move synchronously with the user can be created in an IVE. Researchers can also use IVE to selectively craft virtual humans so that experimenters can control minute details (Bailenson, Blascovich, Beall, and Loomis 2001). In the physical world it is very difficult to filter out the multitude of cues that contribute to any given experience. For instance, if researchers want to study the effect of body posture on perceptions of a speaker's credibility, they must deal with several confounding cues, such as the speaker's natural facial expressions, head movements, and gestures. Using virtual humans, these cues can all be removed or neutralized to allow the scientist to examine cues "in a vacuum." Another advantage is that the exact same stimulus can be replicated and shared with other scientists almost flawlessly for countless iterations of experiments, eliminating variance that may impact outcomes (Blascovich et al 2002).

Consider, for example, the use of confederates, actors in studies who perform similarly scripted behaviors every time a subject is run in a study. When the confederate is replaced with a computer programmed virtual human, the variability of that presentation is limited and precisely replicated down to the second and millimeter (Bailenson, Beall, Blascovich, Weisbuch, and Raimmundo 2001). In the real world, however, multiple confederates may vary on their demographic characteristics, appearance, or nonverbal behaviors in a way that causes unintentional fluctuation in the stimulus. Even the same confederate may vary on manner of mood, dress, eye contact, or

degree of precision in adherence to the experimental script on a day-to-day basis. IVEs offer subtle control for such fluctuations by parsing out individual variables and ensure that unintentional cues are avoided.

Finally, thanks to the incorporation of sensitive tracking devices in IVEs, researchers can go above and beyond traditional means of measuring the users' naturalistic responses (Blascovich et al 2002; Loomis et al 1999). Typical methods of assessment and data gathering such as survey responding, observation, and audiovisual recording work in IVEs as easily as in other contexts, but IVEs offer further advantages to data collection. For instance, IVEs can be programmed to automatically record data regarding the user's movements, gaze, and gestures (Yee et al forthcoming), alleviating the subjective and often painful process of having coders review videotape. These functions also gather data almost continuously, reporting at fractions of a second that are too minute for human coders to make distinctions. The level of detail presented in the behavioral data can serve as meaningful supplements to surveys and self-report questionnaires. These affordances make IVEs ideal environments to study human cognition and behavior.

In addition to introducing IVE technology as a viable research platform and tool in examining social science questions with many potential benefits, Loomis, Beall, and Blascovich also made significant contributions to virtual human research in general by providing concrete theoretical frameworks to guide the interdisciplinary research efforts. Together, the three trained psychologists worked closely to organize and provide structure to the fuzzy concepts based on intuition such as the perception of presence within the IVE. In a seminal piece, Loomis (1992) made one of the earliest efforts to apply the psychological construct of *presence* to IVE research, explicating how users come to believe that the synthesized environment is real via bedrock theories in perceptual psychology.

Blascovich and his research team went on to propose a theoretical framework of how virtual humans are able to socially influence real humans in IVE (Blascovich and Beall 2010; Blascovich et al 2002). According to this framework, virtual humans are able to exert social influence on humans (e.g., persuasion, mimicry, modeling) by way of four different factors. First, the degree of a virtual human's social influence depends on

whether the user believes that the virtual human is controlled by a human or a computer. Avatars are distinguished from *agents*, another form of digital representation, by the element of control: avatars are controlled by human users, whereas agents are controlled by computer algorithms (Bailenson and Blascovich 2004). This perception of agency interacts with the perception of communicative realism—that is, the accuracy of the virtual human's verbal and nonverbal behaviors. Then, communicative realism must be paired with realistic low-level behavioral response systems that are inherent to human nature such as startle responses or proxemics (i.e., automatic maintenance of interpersonal distance). Finally, the degree of relevance of the interaction situation to the user moderates the threshold of communicative realism required of the virtual human to exercise social influence on the user; the greater the situation-user relevance, the greater attention that the user pays to the communicative realism of the virtual human.

Such theoretical and conceptual frameworks coupled with advantages in stimuli creation and data collection have reduced many shortcomings and inherent flaws of empirical work in social science. IVE technology encourages users to manifest natural responses even though they are within a highly controlled virtual world, yielding the benefits of both experimental control and ecological validity. As a result, researchers have been able to examine a wide variety of social psychological phenomena within IVEs, including nonverbal behavior (Bailenson et al 2003); behavioral mimicry (Bailenson and Yee 2005); interpersonal persuasion (Guadagno et al 2007); behavioral modeling (Fox and Bailenson 2009a); social facilitation and inhibition (Blascovich et al. 2002; Hoyt, Blascovich, and Swinth 2003); memory (Segovia and Bailenson 2009); leadership (Hoyt and Blascovich 2007); brand preference (Ahn and Bailenson forthcoming); prosocial behavior (Gillath et al 2008); and prejudice and stereotyping (Dotsch and Wigboldus 2008; Fox and Bailenson 2009b; Groom, Bailenson, and Nass 2009).

The growing number of social scientists embracing IVEs as a new research tool evidences the efforts of Loomis, Beall, and Blascovich in pioneering and validating research conducted within IVEs and actively reaching out to colleagues in their respective fields to explore the possibilities of the new technologies. Considering the high rate at which new media such as the Internet and mobile devices have spread, social scientists should take continued interest in emergent immersive technologies and the

virtual humans that reside in IVEs to interact with humans and influence their emotion, cognition, and behavior.

Behind the Science—Jim Blascovich

Jim Blascovich obtained his Ph.D. at the University of Nevada in social psychology. As a scholar interested in social influence, he felt that IVEs and virtual humans had the potential to answer many social science questions that were either difficult or impossible to empirically test in traditional labs. “It dawned on me while experiencing a ‘pit’ demo in Jack Loomis’s lab that immersive virtual environment technology could benefit experimental social psychology” (personal communication; August 21, 2010). Since this realization, Blascovich has worked closely with his research team at UCSB from 1996 for over a decade to construct a structural model of how humans interact with and respond to virtual humans in IVE. These efforts have been documented in his seminal publication in a 2002 issue of *Psychological Inquiry* that promoted the use of IVEs and virtual humans as a methodological tool in social science.

Blascovich’s theory of the social influence of virtual humans implies that users will respond to virtual humans in the same way they react to other humans regardless of graphical and technical sophistication as long as they perceive the virtual human to be controlled by a human being. Despite active research on how virtual humans can benefit IVE users in domains such as teaching (Blascovich and Beall 2010) or promoting prosocial behavior (Gillath et al 2008), they may also pose ethical issues that users may not be prepared to address. For instance, users may manipulate virtual humans to their advantage by designing one that resembles a particularly influential person or creating an algorithm that makes a virtual human seem to be controlled by a real person rather than a computer. When users mistakenly perceive an agent to be an avatar and respond to the agent as he or she would behave toward another human, opportunities to abuse this trust may arise.

In this light, it is obviously important to learn as much as possible about virtual humans and how they impact human users. In particular, Blascovich predicts, “people are using avatars heavily even today . . . but in non-immersive virtual places like Second Life. I believe that the big impact of avatar use will come when immersive virtual reality technology becomes ubiquitous in people’s homes” (personal communication; August 21,

2010). With the introduction of consumer oriented tracking systems such as the Nintendo Wii, it is likely that IVE systems will become ubiquitous in time, diffusing into homes and everyday lives. Blascovich foresees that IVEs will have major impacts on our society as a whole and thus strives to gain greater insight on virtual humans within IVEs. Thanks to his efforts to provide the field with a solid theoretical framework and rigorous scientific methods of experimentation, virtual human research continues to gain momentum.

Case Study 2—Computer Science Meets Social Science

Due to the highly technical nature of virtual environments, virtual humans were originally a topic of interest among computer scientists who were interested in developing greater technological sophistication such as higher resolution images and more accurate tracking devices. One of the most prominent scholars in this field is Jonathan Gratch, who has been a major part of the academic discourse on using virtual environments for military or medical training. If Loomis, Blascovich, and Beall worked to embrace virtual humans as tools to add accuracy and control in social science experiments, Gratch worked in the opposite direction—using social science concepts as tools to create more human-like virtual humans. That is, Gratch employs emotional and behavioral theories of human nature to create agents and avatars that behave and respond like real human beings.

Using People to Study Avatars and Agents

A computer scientist by training, Gratch is currently an Associate Director for the Institute for Creative Technologies (ICT) at the University of Southern California. The ICT was established in 1999 with a grant from the U.S. Army to open new horizons in training and education through the development of interactive digital media. A decade later it has become arguably the most advanced center examining virtual humans in the world. Together with his research team at ICT, Gratch works to develop virtual humans that employ computational models of human cognition and emotion through verbal and nonverbal responses. As virtual environments become more widespread, more opportunities to interact with virtual humans will arise. In particular, computer-driven

agents present numerous benefits, including conservation of human resources, a decrease in human subjectivity and bias toward other interactants, and minimization of human error. Gratch and his colleagues "envision virtual humans that cohabit virtual worlds with people and support face-to-face dialogues situated in those worlds, serving as guides, mentors, and teammates" (Rickel et al 2002: 32).

Regardless of their level of graphical sophistication, agents have yet to completely replace their human counterparts because of the lack of technical solutions that allow agents to perceive and react to human emotions and behaviors. We are not yet at the point where a purely computer driven agent can trigger a high sense of *social presence*, or the sense that one is interacting with another real human being (Lee 2004). Building models of verbal and nonverbal human communication systems to embed into a virtual agent is a daunting task because of the sheer richness of human emotion, cognition, and behavior. Consequently, a typical researcher tends to focus on single, particular domains of affective computing without considering universal application of the technology. For instance, a single research team may only focus on reproducing behavioral animations of an agent's arms while another team focuses only on reproducing realistic facial expressions without considering the importance of the interplay between both. On the other hand, the foresight shown by Gratch and his team is unique, as they are at the forefront of building the complete virtual human, integrating a number of different elements studied by various research groups. By working to standardize the tools and interfaces of agents to allow "plug-and-play" applications of one another's findings, this synergy is likely to open new doors for all involved in the research process (Gratch et al 2002).

To date, there are virtual agents that are able to interact as a collaborative instructor or teammate with human participants, programmed to follow a set of general, domain-independent operations that supply the agent with task knowledge. These agents are useful for training people on well-defined tasks that follow explicit sequences such as equipment operation or maintenance (Rickel et al 2002). However, when more complex situations that require intricate decision-making processes are introduced, domain-independent modules lack the flexibility and complexity involved in most human-human interactions. To this end, Gratch and his research team developed the Mission Rehearsal

Exercise (MRE) project, a virtual simulation world that presents dilemma situations with intense emotional and cognitive engagement. In this simulation, the user takes on the role of a military leader facing difficult, time-sensitive decisions while interacting with virtual agents to resolve situations. If virtual agents can harness the multitude of human emotions and behaviors, thereby allowing users to believe that they are interacting with real humans, the MRE would serve as a cost-effective and powerful training tool both inside and outside of the military community.

Gratch leads this multidisciplinary collaboration, working to integrate numerous layers of human traits such as emotive behaviors (e.g., body gestures, acoustic realization, and facial expression) and automated speech synthesis into virtual agents. Many correlated and synchronized behaviors come so naturally to people that they only realize that something is amiss in the absence of synchrony, which can result in a *break in presence* (Slater and Steed 2000). For instance, a head turning without the eyes naturally following or speech stripped of natural body movement look awkward, although people rarely make conscious efforts to couple these behaviors together. Thus, social science theories that document and investigate these emotions and behaviors are needed to accurately incorporate human dynamics into computer-driven agents. More importantly, the agents not only display human traits, increasing their believability, but they also perceive and respond appropriately to the emotional and behavioral cues of human users, enabling a dynamic and interactive relationship between human and agent.

For example, negotiating tactics in delicate situations with numerous possible outcomes (Sillars et al 1982) can be implemented into agents in training simulations for human users. Maatman, Gratch, and Marsella (2005) conducted actual role-play sessions between human participants to test out various negotiation theories and strategies in real life, and then the team modeled the agents' interfaces based on these real life simulations. Furthermore, the agents were programmed to demonstrate sophisticated models of emotional reasoning (Gratch and Marsella 2004) and to use a rich model of dialogue (Traum and Rickel 2002) that decides when agents should speak and what they should say. These agents are also able to work their reasoning modules based on the beliefs, motivations, and even the emotions of other agents in the simulation. Much attention has also been paid to incorporate subtle nonverbal cues such as listening behavior (Maatman,

Gratch, and Marsella 2005) to engineer the agents to perceive and respond to the full richness of face-to-face interactions. For instance, Gratch incorporated speech communication theories on the relationship between pause duration and feedback to ensure that the virtual agents react to the voice pitch and pause interval of human users. As a result, human trainees are able to interact with virtual agents that respond naturally to dynamic strategy shifts, verbal and nonverbal communication, and task outcomes.

Potential applications for these naturalistic agents seem limitless. Virtual patients could help clinical specialists hone their doctor-patient communication skills (Kenny et al 2007); aid negotiation training even for highly complex and sensitive situations involving multiple interest parties (Traum et al 2008); and provide realistic simulations that prepare individuals for potentially intense and extreme situations such as decision-making and negotiating in conflict situations (Gratch and Marsella 2003; Rickel et al 2002). Although it may be some time before agents are able to reproduce the full extent of the richness of face-to-face interactions, these advances have contributed to both our basic and applied knowledge of the use of virtual humans. As Gratch and his team continue to bring the wide range of research communities together through standardization and integration, virtual agents with the capacity to seamlessly model human emotion and behavior will continue to be used in domains such as teaching and training and become more versatile and widely used in the future.

Behind the Science—Jonathan Gratch

Gratch points out that one thing has stayed constant since obtaining his doctoral degree in computer science at the University of Illinois in 1995: his passion for interdisciplinary research. “Pasteur argued that chance favors the prepared mind, and that is probably an apt description for how I came to be a researcher in virtual environments. My path to the field has resulted from a number of happenstance deflections: from studying biology and human behavior to ‘hardcore’ artificial intelligence and computational models of human cognition to models of human social behavior in virtual environments” (personal communication; August 13, 2010).

In the early years of virtual human research, researchers were fixated on the goal of creating “believable” characters with an overarching theoretical assumption that simply adding human-like traits would lead to positive outcomes. Gratch argues that

computer scientists approaching the theme of virtual humans from a single perspective can be too "naïve." That is, he feels that human interaction is too rich and complex for there to be a simple correlation between the number of human traits included in a virtual human and the success of interaction. Another issue is the social meaning and cultural context of behavior. An intense gaze would be uncomfortable between strangers, but would be flattering between lovers.

Gratch's understanding of interdisciplinary fields has driven him to not only develop engineering techniques for modeling human behavior onto virtual humans, but also to focus on the social meaning of these behaviors. He strives to develop virtual humans that are able to perceive and respond according to these meanings and the changing dynamics of interaction. Thus, although many people classify him only as a virtual human researcher, Gratch points out that the role of emotion in human belief, motivation, and behavior serves as the cornerstone of his research and informs his scientific perspective.

His breakthrough research with Stacy Marsella (Marsella and Gratch 2009) views emotion "as a part of a system that calculates the personal significance of an event or social situation, and serves as a guide for action, decision-making, and social behavior" (personal communication, August 13, 2010). Their computational model of emotion dynamics allows researchers to use computers to simulate these calculations to infer how a person might feel and act in a social situation. As such, the virtual humans developed by Gratch and his research team rely on these emotion models to perceive, process, and infer what the human counterpart may be feeling or thinking. In other words, these virtual humans make an attempt to decode *meaning*, an idea that could significantly influence future research on virtual humans.

On the other hand, Gratch also warns that despite the profound benefits virtual humans can bring to society, there are many opportunities for abuse as well. As virtual humans are able to model and mimic human emotion and behavior with greater accuracy, the distinction between virtual and real humans becomes blurred. Despite their abilities to display emotion that can seem sincere and friendly, virtual humans lack complex "moral compasses" to guide their behaviors. It may be quite a while, or even impossible, before researchers devise a computation model of morality to apply to virtual humans.

Another issue arises from the ambiguous status of virtual humans as something that look and act like humans but are not. It is likely that people may not feel moral outrage at someone killing or torturing a virtual human. In games like *Sims* or *Grand Theft Auto*, for instance, many players wield violence toward video game characters without remorse. The concept of life and death becomes ambiguous as it can just be a matter of restarting the game to begin a new 'life.' Gratch worries that the reality of the virtual environment is high enough to create some confusion over virtual and the real, triggering a moral disengagement that may translate into antisocial behavior in the real world. Ethics and morals in virtual reality and toward virtual humans is a theme lesser approached amidst the excitement surrounding the advanced technology. Such ethical issues warrant scholars' attention as much as any other theme of research and that researchers should take interest in not just the apparent empirical effects of virtual humans but go on to examine their deeper influence on society as a whole.

Conclusion

In 2010, more than 55,000 users logged in on a weekly basis to Second Life, a virtual world where users can control their own avatars to live as a member of a virtual community. To those unfamiliar with new media and technology, it can be a mystery as to why so many people would choose to spend time with virtual acquaintances over their physical ones. Some suggest this is because virtual worlds allow users the freedom to build their own personalized life narrative (Meadows 2008). Others argue that users begin to build a deep and involved relationship with their avatars where, in time, the user and the avatar's beliefs, motivations, and identities begin to merge together (Waggoner 2009).

IVE technology will become more widespread in time, and it is likely that its unique affordances will attract even more users to embrace human-virtual human interactions. With more human-virtual human relationships, it will be imperative for users to be aware that interactions with virtual humans are not always just games. Virtual or not, we will be interacting with human representations within IVEs, and the high intensity and reality of the interaction will lead to lasting psychological and behavioral effects on users that extend into the real world. Greater caution is in order also because

the development of agents that can behave like humans implies that it will become more difficult to differentiate agency: is the virtual human controlled by a human or a computer? In essence, the growth of IVE technology is not simply an introduction of a new medium, but the advent of a collaborative and social arena of communication and relationship-building.

Consequently, the future of virtual human research must maintain a parallel advancement of both technological and social scientific concepts with a focus on integration. The researchers presented in this chapter have initiated the efforts toward such interdisciplinary work, but there is still much to be done. Although building accurate models that recreate every detail of the physical world or building an avatar that looks exactly like a real human is important work, virtual human research will progress to greater heights if researchers place more emphasis on theoretical advancement, including increased attention on building conceptual frameworks using a multi-dimensional and interdisciplinary approach.

There is a place for every researcher in these endeavors, from the social scientist who is wary of new technology to the computer scientist who is unfamiliar with the study of people. For example, identification with avatars is an important social science question that can be approached by scholars from a wide range of disciplines such as philosophy, psychology, and communication. Preliminary research has already confirmed that game playing activity with an avatar creates a mental connection between the self and the avatar, triggering particular behaviors related to the avatar with which the user identified (Eastin, Appiah, and Cicchirllo 2009). Future research should examine the underlying mechanism of the process of identification and how certain technical features (e.g., users are able to visualize their ‘ideal’ selves through their avatars) can either encourage or discourage users from identifying with avatars. In this way, when scholars from different fields gather together to each provide different pieces of the same puzzle, the big picture is bound to appear much easier and sooner than a single research community’s efforts to tackle the question.

Virtual environments give people the freedom to build their own stories and characters from scratch. These virtual humans can be controlled by a human or a computer, look like blue extra-terrestrials or exactly like the user, and behave like a

human with uncanny accuracy or fly through the air to transport to another location. The user's imagination is the only limit to how the story unfolds. Yet, we should not forget that ethical responsibility should accompany this seemingly boundless freedom. A virtual human can not only look and behave like us, but once we form a psychological connection with the virtual human, it can *become* us. As virtual human research continues to make rapid progress, scholars should also heed the concerns of the leaders and come together to discuss legal and ethical issues that may arise within virtual worlds in the near future. With such interdisciplinary collaborations, we can be hopeful that virtual human research will garner only the benefits of social interactions with avatars and agents while maintaining tight control over negative consequences. As Blascovich notes, "It is the motivation of the human user that decides above all whether virtual humans will help or harm us" (personal communication; August 21, 2010).

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