Understanding The Influence of Agency and Anthropomorphism on Copresence, Social Presence and Physical Presence With Virtual Humans

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Introduction

The growth of the Internet, the diffusion of access to technology, and boosts in bandwidth, have facilitated people's ability to increasingly use telecommunication technologies to create and maintain both business and social relationships (Chesebro & Bonsall, 1989; Rice & Love, 1987; Siegel, Dubrovsky, Kiesler, & McGuier, 1986). More people are using the environments to maintain a broader range of social relationships. People have not only responded socially to one another across mediated channels, but they have also responded socially to the computer interfaces themselves (Nass, Lombard, Henriksen, & Steuer, 1995; Nass & Moon, 2000; Reeves & Nass, 1996). In this sense, networked virtual environments include social interactions with other humans and with the computers themselves.

Thus, networked virtual environments are social; they are also "places." This study focused on social interaction in visual virtual environments. These environments are designed to transmit a strong sense of being inside the media created, or virtual, environment. But more importantly the visual and spatial components of the environments support the creation of mental models of those one interacts with in the environment. The environments facilitate the design and use of computer graphic representations of the other (i.e., avatar) and include text or voice interaction in a spatial environment. These places are increasingly inhabited by virtual humans, visual computer representations of both human and

non-human entities in games, online shopping environments, and educational simulations (Cassell, Sullivan, Prevost, & Churchill, 2000). In this sense, virtual images are computer graphic representations that embody or represent an entity as it interacts with a user in cyberspace.

Virtual images represent virtual humans in computer mediated interactions. Virtual humans differ from one another in a variety of ways along a number of dimensions. This study focused on two dimensions that have important theoretical implications, agency and anthropomorphism. The philosophical and psychological concept of agency has many subtle dimensions (e.g., Bratman, 1999; McCann, 1998), but most conceptualizations tap the core concept of the volitional or intentional force that drives the actions of an entity. IN networked virtual environments, the term agent has been used to describe an entity whose actions are controlled by the computer itself.

Recent advances in artificial intelligence have begun to blur the distinction between human-human and human computer interactions as computer programs, or 'bots' have increasingly been able to do a wide range of tasks (Brent & Thompson, 1999; Dryer, 1999; Nass et al., 1995). By convention, a virtual human controlled by a human in real time is labeled "avatar," but it would be labeled an "agent" if an artificial intelligence or a computer controlled it. Of course, the control over the graphic representation of the user, or the computer graphic puppet, can swiftly be moved from human (avatar) to computer program (agent) and back again during an interaction (Oravec, 1996).

In the networked social places inhabited by virtual humans, the user may feel some level of connection with those he or she encounters while at the same time automatically constructing a mental model of the other. This mental model is extended and clarified as the user works to understand and predict the intentions, and future behaviors, of the virtual other. This study asked whether or not users would feel the same level of copresence, or social presence with non-human artificially intelligence agents as with human- controlled avatars and how this level of perceived connection with a virtual other would influence the sense of presence in the environment. Does it matter if the mind controlling the virtual human body is human, or is it enough to feel a connection to another mind whether it is human or artificial?

Another important dimension of virtual humans is in the visual characteristics of their virtual image. The virtual images animated and controlled by human or artificial minds vary in shape, features and abilities. They vary far more than physical bodies as computer graphics can allow them to be any shape, species, color, or form as they are limited only by the imagination of the creator or designer. The shapes or forms of the virtual body also vary in how much they resemble human bodies. In other words, they differ in their level of anthropomorphism. Anthropomorphism is the second dimension of virtual humans considered in this paper.

A computer-generated image may or may not have much relationship with who or what is actually being embodied. This means that the virtual embodiment

of the intelligence is polymorphic, or it could take any shape (Fisher, 1997). This may have advantages or disadvantages for human communication (Lanier, 1992; Lanier & Biocca, 1992). It would be advantageous if, for example, shape could be altered to dynamically to express a range of personalities and moods to facilitate people's ability to communicate. On the other hand, it could be disadvantageous if the virtual image distracted users from the purpose of the interaction or intended message such as if, for example, the computer generated images negatively influenced person perception.

This ambiguity about the value of anthropomorphism raises the second question addressed in this study: If interactions were equal in all respects except the anthropomorphism of the other body, can user's feel the same level of social presence with virtual bodies that appear less-human (anthropomorphic) as compared to virtual bodies that conform more closely to the shape of the human body? Is the "default" body contained in a person's mind the one that most resembles the physical human body? Does this matter to human communication? Are users really free to take on any shape as virtual humans? What are the implications for their ability to successfully communicate with others? How does it affect the interaction?

The answers to these questions get at the very heart of long standing questions surrounding the human evolutionary responses to agency and anthropomorphic images. Historically people have spent much effort marking the boundary between humans and non-human be it animals, robots, and artificially

intelligences. (Sheehan, 1991a, 1991b). On the other hand, people have tended to project intentionality, or other human abilities to non-human entities (Dennett, 1996). But this ambiguity in interacting with entities that differ in anthropomorphism and agency also has a very practical bearing on the design of virtual humans. Whether the virtual humans people encounter in networked environments are humans or bots and how they are embodied may influence work related or social tasks and their behavior in computer games or other contexts that make heavy use of virtual humans (e.g., Cassell et al., 2000).

The Social Nature of Virtual Environments

Any mediated virtual environment where two or more people interact is by definition social. Virtual environments can vary in the degree to which they support or provide various verbal and non-verbal cues. The context of the interaction varies as well (i.e. business interactions or social chat rooms). The fundamental issue for media designers and users cannot be defined solely in terms of the hardware itself, nor in terms of the number of cues a medium provides. The critical factor in designing an interface should be the user's perception of, or satisfaction with, the interaction or interface. It is important to determine the extent to which the interactants perceive themselves to be connected with another mind, or feel able to fulfill their interaction goals in the environment.

Even low bandwidth (cue lean) mediated interactions have been reported to provide a very strong and distinct sense of a connection with other minds (Parks & Floyd, 1996; Schiano, 1999). People have formed supportive and close friendships with others they encountered in these online environments (see Fisher, 1997; Parks & Floyd, 1996; Parks & Roberts, 1997; Turkle, 1995). The clearest example of the development of community in a cue lean environment was illustrated in Dibbell's (1993) portrayal of the rape in cyberspace. This article depicts how a person was able to make others feel as if they had been violated, in a text only online chat room. The chat members' responses left little room for doubt that they felt part of a community.

Even the word "virtual" suggests that virtual environments have been considered to be distinct from physical environments. In the physical sense many people have judged experiences in the virtual world to be less real or not as meaningful when compared to those in the natural world. It is important to raise the question of whether or not virtual experiences are less socially meaningful or real. For example, is a telephone conversation or email interaction any less real and meaningful than a face-to-face conversation? Why would it be? At the same time, how could it not be?

When people began interacting in chat rooms, experiences outside the chat room were referred to as IRL (In Real Life), which was contrasted to the 'unreal' experiences in the virtual or mediated world. But the perception that mediated social interactions are not real, or are less valuable than natural

interactions has diminished as people have developed meaningful friendships and as users have developed a sense of community online. In other words, virtual interactions have begun to have more social repercussions and meaning.

To some, the idea of people emotionally responding to a “text-based” rape may seem ludicrous. But virtual environments increasing in sensory realism, degree of social involved, and in their ubiquity in society (Biocca, 1997; Biocca, 2000; Biocca & Nowak, 2001). At the same time, the ability of media to provide the sense of a connection with another mind has appeared to be improving. Now as experiences in cyberspace are becoming more meaningful, the use of “IRL” and the use of the term” real” to refer to experiences and relationships that exist outside (as opposed to those inside) virtual environments has been deemed objectionable.[1] Users have perceived their online experiences to be just as real as natural experiences (see Fisher, 1997; Turkle, 1995; Watson, 1997). From participant observation and interviews, researchers have shown people have strong attachments to one another and feelings of community in these virtual environments and interactions (Parks & Floyd, 1996; Parks & Roberts, 1997; Schiano, 1999; Schroeder, 1997; Suler, 1996, 1997; Watson, 1997).

In summary, this section suggested that networked virtual environments are increasingly social and that users perceive online interactions as real. The next section examines the influence of people’s perceptions of agents and avatars.

Perceiving non-human entities: The intentional stance.

The philosopher Dennett suggested that people have adopted a successful evolutionary strategy in dealing with entities. He called this strategy the “intentional stance.” (Dennett, 1987, 1996). The intentional stance is the strategy of interpreting the behavior of an entity (whether the entity is a person, animal, or artifact) by treating it as if it were a rational agent who governed its “choice” of “action” by a “consideration” of its “beliefs” and “desires.” (Dennett, 1996, p. 27). The terms are in quotes because they are terms that are believed to be part of the everyday person’s theories of other minds “often called ‘folk psychology,’ the everyday psychological discourse people use to discuss the mental lives of our fellow human beings” (Dennett, 1996). The intentional stance has been generalized to explain and model people’s responses to many other entities in the environment: animals, robots, and, for the purposes considered here, animated blotches of light on the screen.

The processes associated with the intentional stance appear to be automatic. They may be triggered by a person’s perception of “agency,” or entities in the world that appear to be volitional and self-guided. For example, a rock or a plant may not appear to have agency if it did not appear self-propelled. When a rock or plant moves in the natural world, it could not be self-propelled but could propelled by some other force. But humans, animals, robots and animated characters in the virtual world can be self-propelled and thus may appear to have

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[1] This is why the term "natural" world is used instead of instead of real world.

agency. In these terms, having agency may trigger some form of modeling of the "beliefs," "attention" and "desires" of the entity. These kinds of attributions may be part of the process of assembling a model of the other mind. An understanding of this process can shed a great deal of the light on the theorizing and measurement of the mediated connection to another physical or artificial mind (Biocca et al., 2001; Nowak, 2001; Nowak, 2000b).

Under the sway of the intentional stance, people have generated mental models of other people, and they have also generalized this strategy of devising mental models to animals and objects. The processes of modeling other's beliefs, intentions, and desire have been shown to be similar for various intentional entities. However, different categories may become relevant and accessible when the perceived entity is believed to be human as compared to any other entity or object encountered in the environment (Heider, 1958; Konner, 1991; Ritvo, 1991; Sheehan, 1991a, 1991b; Tagiuri, 1958). There is evidence that people make distinction between humans and non-humans, animate and inanimate from an early age (Keil, 1994). At the same time, people have tended to over generalize the notion of intentionality to many entities (Dennett, 1996, p. 27). However, it may be that the categories that differentiate humans and non-humans are not salient, accessible, and utilized when interacting with all virtual humans. If they were, then there would likely be some difference in the sense of connection with a human mind when compared to the sense of connection with a non-human or inanimate mind (Nowak, 2000a, 2000b).

Hanging out with humans, agents, or robots: Does it matter?

This section examines what might be expected regarding users' responses to the new neighbors who have moved into these increasingly social virtual communities, the non-human agents. Technological advances have led to the increasing ability of agents to mimic the social behaviors of humans (Cassell et al., 2000) and people have responded socially to these agents (Koda, 1996; Nowak, 2001b; Reeves & Nass, 1996). One stream of theorizing on this issue has focused on the social-psychological health of this "unnatural" social interaction. There has been some concern about how the tendency of human users to respond socially to computers themselves and to computer-controlled characters and whether this will influence people's ability to successfully function in the information age (Don, 1992; Laurel, 1990; Turkle, 1995). Some of this concern is of ethical nature, part of a long-standing discomfort at the confusion of the boundaries between the human and non-(Sheehan, 1991a, 1991b). Other concerns have to do with the psychological health of users who treat the computer as a partner and friend, and the implications of interaction with future interactions with "real" humans (Don, 1992; Laurel, 1990; Turkle, 1995).

Other debates about the influence of people's interactions with agents are of a more practical in that they deal with the issue of whether or not agents can improve the usefulness of media interfaces. Some researchers have found that people tend to respond socially to the computer interface itself, because it exhibits human behavior such as the use of text, interaction style, personality

variables or a variety of other examples (Reeves & Nass, 1996). Their argument has been that such social responses occur, are natural, and must be considered during the process of designing or understanding responses to an interface. Others, like Shneiderman (1997) have found that the use of anthropomorphic entities in interfaces may mislead the user into believing that the interface can exhibit more social skills than the interface can support. This, he argued, guarantees that the interface will fail because the user will inevitably experience frustration with the social limitations of the computer that they are bound to eventually discover.

Is the traditional human body the more powerful way to transmit social cues in virtual environments?

This section examines the extent to which the shape and behavior of the virtual body may influence the perception of and connection with the other, and the interaction itself. In the natural world, people have been very sensitive to communication cues provided by body morphology and movement and they used them in the person perception process (Argyle, 1988b; Burgoon, Buller, & Woodall, 1996; Ekman & Friesen, 1969; Mehrabian, 1972). People also rely on the physical features of others for social judgment (Argyle, 1975, 1988a; Hinton, 1993; Ichheiser, 1970). In a variety of ways and contexts, bodily cues have been used to categorize and judge others (Bruner, 1957; Fiske & Neuberg, 1990; Srull, Lichtenstein, & Rothbart, 1985).

Visual representations of computerized others raises the question of how those visual representations influence person perception. When the bodily cues are computer generated and not natural, will people rely on them for person perception and social judgment or ignore them because they are completely fabricated and, therefore, untrustworthy? The disembodied others encountered in mediated environments may not provide all (or even any) of the traditional cues that people have come to rely on for perceiving others. At the same time, virtual environments may provide various kinds of new, dramatic embodiment cues that might enhance interpersonal interaction (Lanier & Biocca, 1992). Interaction in social virtual environments may force the reconsideration of some of the assumptions and judgments people have made of others based on their experiences in the natural world.

In terms of designing interfaces and interacting with others, the potential influence of the interface or the medium on the users cognitive processes and perceptions of the interaction and message become important factors to consider. To understand what someone is saying, why they said it, and the social implications of the message, any interaction with another immediately triggers people's need to determine ***who*** sent the message, and why. The increased prevalence of the virtual body and artificial intelligences in virtual worlds are likely to influence the perception of who sent the message, as well as the message itself.

In the natural world, all living things contain certain common properties that distinguish them from inanimate objects (Asch, 1958; Hastorf, Schneider, & Polefka, 1970; Heider, 1958). It is likely agency, or the extent to which the other is perceived to be human will influence the user's sense of access to another mind. This may mean that, especially in the virtual world, there will be varying levels of "humanness" or qualities that bring up the sense of access to another mind or intelligence that has traditionally been reserved for humans.

The sense of "being there" with another in a social virtual environment: telepresence, co-presence, and social presence.

The purpose of embodiment and agency of virtual humans is to give the user as sense of the other's presence. So a key performance goal of many social virtual environments is to feel as if you are "there" (i.e., telepresence) in the "company of others" (i.e., co-presence). People should feel that the interface could provide some sense of access to another mind (i.e., social presence).

The concept of presence is very large and has a variety of elaborate definitions (Barfield, Zeltzer, Sheridan, & Slater, 1995; Lombard et al., 2000). The concept of mediated presence,[1] known as telepresence (Draper, Kaber, & Usher, 1998; Held & Durlach, 1992; Minsky, 1980; Sheridan, 1992; Steuer, 1994), is most often defined succinctly as the sensation of 'being there' in the virtual or mediated environment (Heeter, 1992; Steuer, 1994). Telepresence has also been defined as a sense that one has been transported from the confines of the

physical environment (Gerrig, 1993; Minsky, 1980). In other words, the user feels immersed (Witmer & Singer, 1994) in the virtual environment represented by the medium (Steuer, 1992). Biocca (1997) and others have described telepresence as the user's compelling sense of being in a mediated space, and not where their physical body is located.

The term copresence originated in the work of Goffman (1963), who explained that copresence existed when people sensed that they were able to perceive others and that others were perceiving them. Further, he explained that in its true meaning, "copresence renders persons uniquely accessible, available, and subject to one another" (Goffman, 1963, p. 22). Ciolec (1982) also considered copresence and emphasized the importance of attention or responsiveness to others. Copresence in this sense solely refers to a psychological connection to and with another person. It requires that interactants feel they were able to perceive their interaction partner, and that their interaction partner actively perceived them (see also Nowak, 2000b; 2001a).

Social presence is the most common theoretical model used to attain information about the connection of people via telecommunication systems (Caldwell, Uang, & Taha, 1995; Fulk, Steinfield, Schmitz, & Power, 1987; Haythornthwaite, Wellman, & Mantei, 1995; Palmer, 1995; Rice, 1993; Rice & Tyler, 1995; Short, Williams, & Christie, 1976; Trevino, Lengel, & Daft, 1987; Walther, 1992; Walther & Burgoon, 1992; Walther, 1996). Short, Williams and Christie (1976) are credited with giving broad theoretical currency to the concept

of social presence. They explain social presence as “the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships” (p. 65). However, their indicators of social presence have been shown to relate to the user’s perception of a medium’s ability to provide salience of another and are not a measure of actual salience of another person.

Hypotheses

Hypothesis I: All other things being equal, people will feel more copresent with an avatar than with an agent.

Hypothesis II: All other things being equal, people will feel more social presence in interactions with avatars than with agents.

People have experienced co-presence with other humans in both the physical and the psychological sense. However, individuals may find it harder to feel co-present with a virtual body controlled by an artificial intelligence. The knowledge that the mind is not human may lead the user to create thin, superficial models of other intelligence and inhibit the sense of true access to the mind, or copresence.

Hypothesis III: People will feel more physical presence in an environment with an avatar than with an agent.

People have experience being in the same place with humans. Therefore, being with another human in a virtual environment may be perceived as similar to the physical environment. Thus, virtual environments with avatars may be more

accessible and feel more comfortable than those populated by agents. This greater accessibility will increase the sense of physical presence.

Hypothesis IV: People will feel less copresence with partners represented by low-anthropomorphic images than those represented by high-anthropomorphic, or without images.

Hypothesis V: People will feel less presence in environments with partners represented by low-anthropomorphic images than those represented by high-anthropomorphic or without images.

Hypothesis VI: People will feel less social presence with partners represented by low-anthropomorphic images than when their partners are represented by high-anthropomorphic or without images.

The shape and the communicative behavior of the other's body is a key cue to infer mental states of others. This is likely to be the case in the virtual environments and with virtual bodies.

Anthropomorphic bodies have been shown to engage the user more and provide a more interesting interaction for participants (Koda, 1996; Takeuchi & Naito, 1995). Users have more experience with anthropomorphic bodies, and the virtual human bodies that most approximate this experience may better activate mental models of social others.

Research has suggested that users continued to categorize other people in social virtual environments using the same categories that are salient in physical environments (Lipton, 1996; Reeves & Nass, 1996; Spender, 1996; Suler, 1996; Takeuchi & Naito, 1995; Waskul & Douglass, 1997). As features of the natural body have provided information for categorization (Argyle, 1975, 1988a; Hinton, 1993; Ichheiser, 1970), it is likely that the features of the virtual body image provide information for categorization in virtual environments. If this

is correct, then just the presence of an embodied other, whether truly human or not, would trigger mental models of human intelligence in observers.

Method

Design

This study used a between subjects experimental design with two factors. The first factor, agency of the intelligent other, had two levels; whether participants were told they were interacting with a human (avatar) or a bot (agent). The second factor, degree of anthropomorphism of virtual image had three levels, high and low anthropomorphism and a control with no virtual image.

Participants

134 undergraduates from a telecommunication department at a large midwestern university took part in this experiment for class credit. Participants were stratified by sex and randomly assigned to condition. There were a total of 94 males and 40 females. The average age of participants was 21, and ages ranged from 19 to 33.

Stimulus Materials

Virtual Confederate's image. The virtual confederate was either represented by no image or by one of two images; a female virtual face (high-anthropomorphic condition, see Figure 1) or a very abstract face with only a mouth and eyes (low-anthropomorphic condition, see Figure 2). The two images

contained the same number of cues including faces with eyes, mouths and noses. The only difference was that one is more iconic (low anthropomorphism) and one appeared more human (high anthropomorphism). In the control condition, there was no visible virtual image, only the virtual room (see figure 3).

Virtual Environment. This interaction took place in a 3-dimensional environment that appeared on a computer screen and resembled a meeting room with a sign indicating that participants were in the scavenger hunt meeting place. In the no image condition, only the environment was perceivable (See Figure 3). In the other conditions, participants first went to the character selection screen (See Figure 4), where they selected the character they wanted to represent them during the interaction. When participants "entered" the virtual environment by pressing the 'enter' button, the virtual confederate's image was already in the room, except in the no image condition where the virtual confederate was there but was not represented by an image. This environment allowed participants to speak into a microphone and hear their interaction partner via headphones.

Audio Scripts. All participants in all conditions heard the same female voice reading the same script. The script began with the virtual confederate (agent or avatar) introducing themselves and then waited for the participant to do the same. Following the introduction, the participant pressed a button marked 'done' to indicate their turn was over. Then the virtual confederate indicated their skills relevant to an Internet scavenger hunt. Following participant's "turn" to

indicate their skills, they pressed the 'done' button and then the virtual confederate said goodbye and indicated a wish to continue working with the participant.

Avatars/Agents. The avatars and agents appeared the same and were represented by one of two images; a female virtual face (high-anthropomorphic condition, see Figure 1) or a very abstract face with only a mouth and eyes (low-anthropomorphic condition, see Figure 2). All participants in each condition saw the same virtual face, which was associated with the same female voice that read the same script. The only difference between agents and avatar conditions was that in the agent condition, participants were told they were interacting with a 'bot' or computer programmed at another university and in the avatar condition, participants were told they were interacting with a student at another university.

Audio Scripts. A female read the script. All participants in all conditions heard the same voice reading the same script. The content of the script contained a short biography, listing their skills relevant to a web scavenger hunt task. The script began with the virtual confederate (agent or avatar) introducing themselves and then waited for the participant to do the same. Following the introduction, the participant pressed a button indicating they had introduced themselves and then the virtual confederate (agent or avatar) discussed their Internet skills. The script included information about the virtual confederate's (agent or avatar) self-proclaimed web experience. Following participant's "turn" to indicate their skills, the virtual confederate said goodbye and indicated a wish to

continue working with the participant. Participants were then given a chance to say goodbye before pressing the button to end the interaction.

Measurement Instruments

The pre-test questionnaire was done on paper and pencil. The post-test questionnaire was presented to the participants using *Surveysaid*, a computerized questionnaire software (Masters, 2000). This Software presents each question one at a time on the computer screen. Participants select their response by clicking the appropriate box with a mouse and then click a button marked “next question” to continue through the questionnaire.

Presence. Presence is a measure of the feeling a person has that they are “inside” a virtual environment, a sense of “being there.” This measure comes from a development of a measure for presence with the subheading of presence as immersion (Lombard & Ditton, 1999). Eight likert-type items with a 7-point metric were used to form a scale. This scale included indicators such as how intense the experience in the environment was and the extent to which the experience was involving and immersive.

Copresence. Copresence as discussed above is related to the feeling of connection between two people. Given its dual nature, this was measured by two separate scales, one asked about the participant’s perception of their partner’s involvement in the interaction and the other asked the participant about their own involvement in the interaction.

The scale measuring the perceived copresence of the virtual confederate (agent or avatar) included 15 indicators taken from three of the dimensions of immediacy. This included immediacy/affection, similarity/depth and receptivity/trust. This scale was derived from a combination of the indicators for intimacy, involvement and immediacy from Burgoon and Hale (1987) receptivity/trust (Burgoon & Hale, 1987). This included whether the other was perceived to be involved, interested or emotional about the conversation. It also included whether or not the interaction partner made the conversation seem superficial or created a sense of distance between the interaction partners. These were likert-type items with a five-point metric.

The second scale included 11 indicators similar to those above, but they were revised to ask how involved the participant was in the interaction. These items measured the extent to which the participant self-reported being copresent in the interaction and included questions about whether they were interested in a deeper relationship or more intimate conversation with their interaction partner. These were also likert-type items with a five-point metric.

Social Presence. Social presence is multidimensional. Here, it is divided into two dimensions; the perceived ability of the medium to provide social presence and the social presence actually felt with an interaction partner.

The first dimension, or the perceived ability of the medium to connect people (ability of the medium itself to provide social presence), consisted of 9 slightly modified items from Short, Williams and Christie (1976). The scale was a

Likert-type scale instrument with a 7-point metric. It included questions about how the person at the other end seemed, whether or not the medium provided a sense of realism, and whether or not one could get to know a person they encountered only through the medium in question.

The second dimension, or the amount of social presence participants felt with their interaction partner, consisted of a semantic differential scale from Steinfield (1986). This was slightly revised to ask about the partner instead of the medium. Thus, the items asked whether participants found their interaction partners impersonal or personal and sociable or unsociable.

Procedure

After signing a consent form indicating their voluntary participation in this experiment, participants filled out their pretest using paper and pencil in a conference room. The pretest asked for demographic information, including biological sex, age, year in school and computer use and chat room experience. Participants then read a piece of paper containing their assignment and the scenario. They were told that their goal was to get to know their partner who may work with them in the future on a scavenger hunt on the World Wide Web. They were also told whether they were interacting with an agent or avatar. The instruction sheet also told participants that if their team were selected they would be asked to participate in an online scavenger hunt where they would search for a variety of computer software and technologies. Further, they were led to

believe that the team that finished the scavenger hunt and found the best prices in the least amount of time would win $100. The participant was then taken to a computer in a computer laboratory and the instructions were explained again in more detail. The participant was verbally reminded that their partner was either an agent or an avatar and any questions participant had were answered at this time.

In the no image condition, participants entered their participant identification numbers and began the interaction. In either of the other conditions, participants entered their participant id numbers, selected a virtual face to represent them in the character selection screen and then began the interaction. The average interaction lasted about fifteen minutes. After the interaction, participants completed the post-test questionnaire. This included measures of presence, copresence, and social presence. After participants completed the questionnaires, they were debriefed.

Results

See Table 1 for summary. An alpha level of .05 was used for all statistical tests.

Scale construction

Standardized item alpha is included for all scales. The dimensionality of each scale was determined in two ways. First, confirmatory factor analysis tests of internal consistency were applied to each instrument. All retained items met the criteria for internal consistency: (a) face validity and (b) a primary factor loading of at least .5. Further, items were removed when they had greater errors with other items than what would be expected by sampling error. Items were dropped from their respective scales when item correlations failed tests of internal consistency. Second, all scales were evaluated together and all items loaded highest on their primary factor. Any item that did not meet all tests was removed from the scale. The final number of items in each scale is detailed when the scale is first used in analysis.

On the influence of Agency

A one-way ANOVA for Agency was conducted for all analyses in this section.

Hypothesis I: People will feel more copresent with an avatar than with an agent

This hypothesis was not supported on either dimension.

The scale measuring the *perceived copresence* of the virtual confederate (agent or avatar) maintained 13 of the original 15 indicators after the tests of internal consistency and reliability (standard alpha = .9) and responses on this scale ranged from 15 to 60. Of eleven items originally included in the scale of *self-reported copresence*, five items remained after the tests of internal

consistency and reliability (Standardized alpha= .78) and responses on this scale ranged from 6 to 30. The items that were dropped appeared to be bad items in this manipulation[2].

The effect of agency on the perception that the virtual confederate (agent or avatar) was copresent is not significant, $F(1, 132) = .27$, $p = .60$. Means (with standard deviations in parentheses) for those in the agent condition and avatar condition 36.48 (9.76) and 37.37 (9.96), respectively.

The effect of agency on the participant's self-reported copresence in the interaction is not significant, $F(1,132) = .37$, $p = .54$. Means (with standard deviations in parentheses) for those in the agent condition and avatar condition were 17.39 (4.13) and 16.92 (4.77), respectively.

Hypothesis II: People will feel more physical presence with an avatar than with an agent.

This hypothesis was not supported. The scale measuring physical presence (standard alpha= .88), retained six of the 8 original items (1= low presence, 5 = high presence) after tests of internal consistency and reliability

The effect of agency on the sense of presence in the environment is not significant $F(1, 132) = .27$, $p = .60$. Means (with standard deviations in parentheses) for those in the agent condition and avatar condition 36.48 (9.76) and 37.37 (9.96), respectively.

Hypothesis III: People will feel more social presence when interacting with avatars than with agents.

This hypothesis was not supported on either dimension.

[2] All of these included a measure of how involved, detached or intimate this particular conversation was. They were not related directly to their perception of their interaction partner. Another manipulation may be a better test of this dimension of the construct.

The scale measuring the perceived ability of a medium to provide social presence (Standardized Alpha .82) was measured on a sliding scale retained all 6 of the original items.

The effect of agency on the perceived ability of a medium to provide social presence is not significant $F(132) = .45$, $t = -.33$. (With standard deviations in parentheses) for those in the agent condition and avatar condition 6.09 (1.44) and 6.17 (1.37), respectively.

Effect of Less Anthropomorphic Embodiment on Presence

A one-way ANOVA with a priori contrasts (-2 no image, +1 high-anthropomorphic image, +1 low-anthropomorphic image) for the effect of a virtual image was conducted for all analyses in this section.

Hypothesis IV: People will feel less copresence with partners represented by low anthropomorphic images than those represented by high anthropomorphic, or no images.

This hypothesis was supported on both dimensions of copresence.

This was tested using a one-way ANOVA with contrasts (+1 no image, +1 high-anthropomorphic image, -2 low-anthropomorphic image). The effect of an anthropomorphic virtual body on perceived copresence of the virtual confederate (agent or avatar) is significant, $T(2, 131) = 2.90$, $p = .00$. People interacting with the less anthropomorphic virtual image reported their partners to be less copresent than those who interacted with either a high-anthropomorphic virtual image OR with no image.

The same trend in the results was found with regard the participants' self-reported copresence in the interaction. People that interact with highly

anthropomorphic virtual images felt more copresent than those that interact with low-anthropomorphic virtual images.

This was also tested with a one-way ANOVA with contrasts (+1 no image, +1 high-anthropomorphic image, -2 low-anthropomorphic image). The effect of a low-anthropomorphic image on people's self-reported copresence is significant, $T(2, 131) = 2.09$, $p = .04$). People interacting with a less anthropomorphic virtual image felt less copresence with their partner than those interacting with either no image or with a highly anthropomorphic virtual image.

Hypothesis V: People will feel less presence in environments with partners represented by low anthropomorphic images than those represented by high anthropomorphic or no images.

This hypothesis was supported.

This was tested with a one-way ANOVA with contrasts (+1 no image, +1 high-anthropomorphic image, -2 low-anthropomorphic image). The effect of a low-anthropomorphic image on people's self-reported .physical presence in the environment is significant. $F(2, 131) = -2.05$, $\underline{t} = .04$. Means for no body 18.63 (6.77), high anthro 19.74 (6.34), low anthro 21.85 (8.05). People interacting with a less anthropomorphic virtual image felt less presence in the virtual environment than those interacting with either no image or with a highly anthropomorphic virtual image

Hypothesis VI: People will feel less social presence w/medium when partner is represented by low anthropomorphic image than when partner is represented by more anthropomorphic or no image.

This hypothesis was supported.

This was tested with a one-way ANOVA with contrasts (+1 no image, +1 high-anthropomorphic image, -2 low-anthropomorphic image). The effect of a

low-anthropomorphic image on people's social presence is significant $F(2, 131) = 2.86$, $\underline{t} = .01$. Means for no body 6.31 (1.38), high anthro 6.42 (1.41), low anthro 5.65 (1.29). People interacting with a less anthropomorphic virtual image felt that the environment could provide less social presence than those interacting with either no image or with a highly anthropomorphic virtual image.

Discussion

The results have implications for various theoretical issues regarding user interactions with virtual humans. Below we consider the implications for how users feel present and respond socially to: (1) human as compared to artificial others, (2) interactants who do as compared to those who do not have a virtual body, and (3) the morphology of the virtual body. The implications for social virtual environment design and use are discussed in order below.

Do users feel equally present with avatars and agents?

When behavior and embodiment is the same, users may feel equally present with what they know to be artificial agents as they do with human avatars. Users felt they had access to another mind and that the mind was attending to them (copresence) whether it was an agent or avatar. There was no difference in their perception of the medium's ability to provide a connection to another mind (social presence), nor was there any difference in the extent to which people felt physically present in the virtual world (presence as transportation).[2] These null findings are consistent with several other studies that suggest that people respond to computers in ways that are very similar to the ways they respond to other humans (Reeves and Nass, 1996). It lends

further support for the propositions associated with the intentional stance (Dennett, 1987), that people ascribe human intentionality to all entities, whether human or non-human.

The anthropomorphism of the virtual body may affect several types of presence

This study examined whether or not the shape and behavior of the virtual body influenced the user's ability to feel various forms of presence. When the virtual human appeared non-anthropomorphic, people felt they had less access to another mind (copresence). They also felt less social presence that is they felt that the medium was less able to support a social interaction. Furthermore, they felt a reduced sense of presence in the place where the social interaction occurred.

Users may have felt less socially comfortable with forms of the body that deviated too much from what they experience in the physical world. This raises the question of why the anthropomorphism of the user's virtual image influence not only the user's judgment of co-presence with the other, but also their judgment of the appropriateness of the medium for social interaction (social presence) and the users sense of presence in the place. Most explanations would suggest some mechanism for interdependence of these types of judgments. Not feeling co-presence with the other might weaken the ability to model the sense of place and lead to reduced expectations about the ability of the medium to support a social interaction. It is also possible that users may experience uncertainly, discomfort, or negative affect interacting with the non-

anthropomorphic others. This negative affect may spread to their judgments of the communication properties of the place and the medium.

A pioneer of virtual reality technology, Jaron Lanier, often suggested that the VR user could easily allow a user to "become a lobster," that is take on another body to dramatically signal some mood change or communicate something specific (Lanier & Biocca, 1992). This finding indicates that users should use the ability to be represented by any body carefully. Altering the virtual image in certain ways might not only detract from social communication, but it might also decrease the other's sense of presence and their evaluation of the medium itself. This finding would need to be replicated to specify the conditions where this might hold.

The default body might be an anthropomorphic body

The difference in the sense of presence between users who interacted with an anthropomorphic virtual body and those who interacted with just voice and no virtual body was not significant. This indicates that people assumed that their interaction partner was anthropomorphic, or appeared human like they were. This finding is consistent with Walter's (1996) conclusion that users were more likely to believe that others were "like them" in low bandwidth systems such as email than in high bandwidth systems where there may be evidence to the contrary. Theories of the psychology of social interaction (theories of other minds) suggests that the individual's model of the other's mind (intentional states) is based on a simulation and generalization from one's own mind (Gordon, 1986). In the absence of disconfirming experience there may be

tendency for the “default other” to be some variation on the self. If this is the case, then the anthropomorphic body and the no-body condition would be more similar than the non-anthropomorphic body condition because the user is projecting a “default body” similar to one’s own on the other. Such a process would be consistent with the findings of this study.

Implications for Design and Use

The effect of anthropomorphism of the virtual body on presence, co-presence, and social presence suggests that judgments of the communication qualities of the other, the medium, and the place may be interdependent. These constructs have been shown to be positively correlated (Nowak, 2001a). This has important implications for the use and design of media interfaces. Specifically, judgments of the interactant may affect judgments of the interface and the perception of the interaction itself. So weaknesses and possibly strengths in one aspect of interface design may have effects on the experience and perception of others which both designers and users should consider.

Conclusion

The results presented above lead to some conclusions that have implications for understanding how people react to virtual humans. It has been argued that people may tend to respond socially to intelligent others, whether the other was artificial or human (Reeves & Nass, 1996). The results from this study suggest that there may be no difference in users sense of presence or copresence whether or not they were interacting with a human. This is consistent with the proposition that users have similar social responses to virtual humans,

whether they are driven by human or non-human intelligence. On the other hand, because these conclusions are based on null findings, they must be interpreted with caution.

At the same time, the results showing significant differences in how people responded to virtual bodies suggest a caveat. There are limits to which the user will accept the "artificial" virtual human. People exhibit more social responses and judgments to virtual humans that look human as compared to those who do not look human. In this experiment, the non-anthropomorphic image appeared to be more than just not human; it was not animal and not similar to anything one may have seen before. It is possible that animal forms might be perceived as more anthropomorphic and possibly more human than the images used in this study. Future research should vary level of anthropomorphism more systematically to explore the extent of various images on these perceptions.

User comfort with level of anthropomorphism may provide explanation for this finding, as well as for the social responses to computers found in the work of Reeves and Nass (1996). As artificial entities take on more anthropomorphic properties –they look human or use language like humans – then users respond socially. As they deviate from human appearance and behavior, users may find it harder to feel social responses. It is the boundaries of when and where these responses are evoked by virtual humans that are not yet clear. This study suggests that response is elastic in that users seem to accept social interactions with artificial others. It also indicates that the response has boundaries as it weakens as body morphology deviates too much from anthropomorphic forms.

Table 1:

Summary table of Hypotheses and Results

Effect of Agency on Presence-Tested with T-Tests		
Hypothesis I: People will feel more copresent with an avatar than with an agent.	Self-copresence F(132) = .03, t = -5.2. Agent condition 36.48 (9.76) and avatar condition 37.37 (9.96). Copresence of other F(132) = .77, t = .38. Means of Agent condition 17.39 (4.13), Avatar Condition 16.92 (4.77).	**Not Supported**
Hypothesis II: People will feel more physical presence with an avatar than with an agent.	F(1, 132) = .27, p = .60. Means (with standard deviations in parentheses) for those in the agent condition and avatar condition 36.48 (9.76) and 37.37 (9.96), respectively.	**Not Supported**
Hypothesis III: People will feel more social presence when interacting with avatars than with agents..	Soc Pres Med Scale F(132) = .45, t = -.33. Means for Agent condition 6.09 (1.44) Avatar Condition 6.17 (1.37).	**Not Supported**
Effect of Less Anthropomorphic Embodiment on Presence Tested using One Way Anova with contrast test (1 no image, 1 high-anthropomorphic image, -2 low-anthropomorphic image).		
Hypothesis IV: People will feel less copresence with partners represented by low anthropomorphic images than those represented by high anthropomorphic, or no images.	Self-copresence F(2, 131) = 2.90, p = .00. Means for no body 38.35 (9.52), high anthro 38.83 (9.46), low anthro 33.47 (9.83). Copresence of other F(2, 131) = 2.09, t = .04. Means for no body 17.45 (4.17), high anthro 17.96 (4.67), low anthro 16.01 (4.29).	**Supported**
Hypothesis V: People will feel less presence in environments with partners represented by low anthropomorphic images than those represented by high anthropomorphic or no images.	Presence. (1= low presence, 5 = high presence). F(2, 131) = -2.05, t = .04. Means for no body 18.63 (6.77), high anthro 19.74 (6.34), low anthro 21.85 (8.05).	**Supported**
Hypothesis VI: People will feel less social presence w/medium when partner is represented by low anthropomorphic image than when partner is represented by more anthropomorphic or no image.	Social Presence Medium. F(2, 131) = 2.86, t = .01. Means for no body 6.31 (1.38), high anthro 6.42 (1.41), low anthro 5.65 (1.29).	**Supported**

FIGURES 1-3. IN EACH CONDITION, PARTICIPANTS VIEWED ONE OF THE FOLLOWING SCENES OF THE VIRTUAL ENVIRONMENT.

Figure 1: High Anthropomorphic Image Condition

FIGURE 2: Low-ANTHROPOMORPHIC IMAGE condition

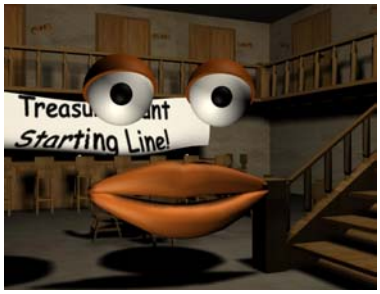


Figure 3. The No Image Condition

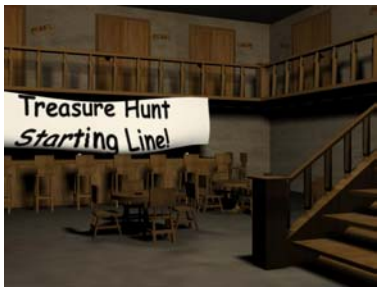
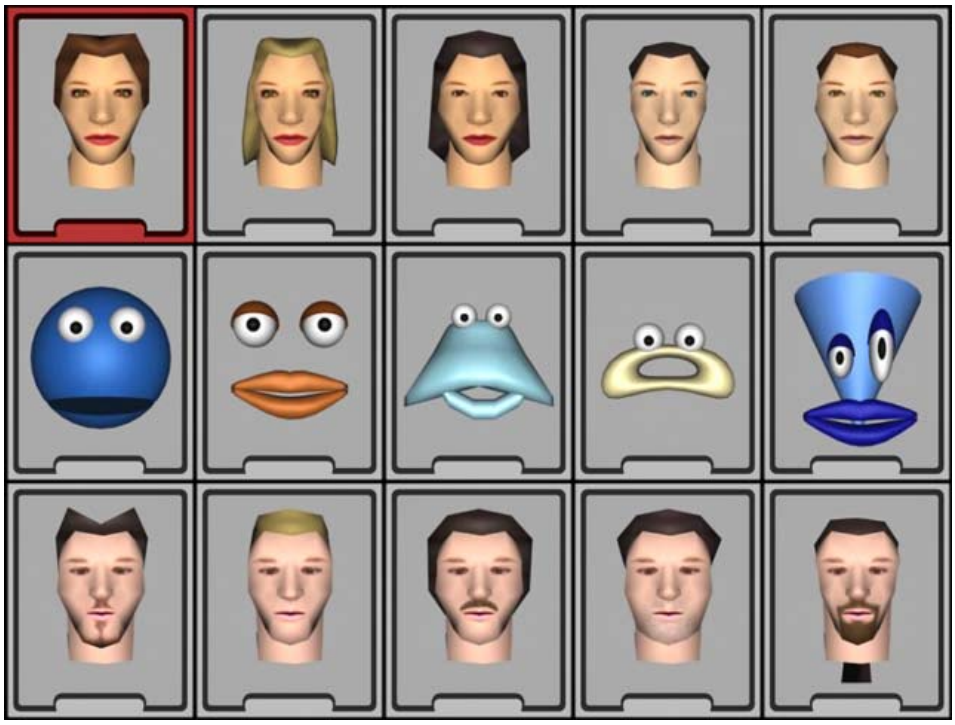


Figure 4. In either the Anthropomorphic or Low-ANTHROPOMORPHIC IMAGE conditions, Participants were allowed to select one of these characters on the Virtual Representation Selection Screen to represent them.



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[1] Mediated presence is sometimes referred to as second order presence (Lombard et al., 2000).

[2] However, it is important to point out that, although there were no differences the means in all of the measures were at about the mean, which are lower than what would have been expected in an interaction and may be explained by the controlled and scripted nature of the interaction.