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The Effect of the Agency and Anthropomorphism on Users' Sense of Telepresence, Copresence, and Social Presence in Virtual Environments

Abstract

We report on an experiment that examined the influence of anthropomorphism and perceived agency on presence, copresence, and social presence in a virtual environment. The experiment varied the level of anthropomorphism of the image of interactants: high anthropomorphism, low anthropomorphism, or no image. Perceived agency was manipulated by telling the participants that the image was either an avatar controlled by a human, or an agent controlled by a computer. The results support the prediction that people respond socially to both human and computer-controlled entities, and that the existence of a virtual image increases telepresence. Participants interacting with the less-anthropomorphic image reported more copresence and social presence than those interacting with partners represented by either no image at all or by a highly anthropomorphic image of the other, indicating that the more anthropomorphic images set up higher expectations that lead to reduced presence when these expectations were not met.

1 Introduction

Technological advances have increasingly enabled computer-generated entities to mimic both the appearance and behaviors of humans (Brent & Thompson, 1999; Dryer, 1999). Questions have been raised about how these appearances and behaviors influence peoples' levels of telepresence or immersion (Draper, Kaber, & Usher, 1998; Minsky, 1980; Sheridan, 1992; Steuer, 1994), copresence, or connection with another human (Goffman, 1963; Nowak, 2001), and social presence, or perception of a medium's ability to connect people (Rice, 1993; Short, Williams, & Christie, 1976). People have reported feeling some level of presence in almost all mediated environments (Rheingold, 1995; Schroeder, 2002) and have even responded socially to both human and nonhuman others as well as to the computer interfaces themselves (Nass & Moon, 2000; Reeves & Nass, 1996; Slater & Steed, 2002).

Visual images representing both human and nonhuman entities increasingly inhabit games, online shopping environments, and educational software applications (Cassell, Sullivan, Prevost, & Churchill, 2000; Schroeder, 2002). These visual images can and do vary on a number of levels and include everything from two-dimensional pictures to three-dimensional animated images

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(Damer, 1997; Talamo & Ligorio, 2001). Improvements in graphics and animation technology have made it increasingly possible for these visual images to appear human-like, or anthropomorphic. At the same time, advances in the development of artificial intelligence have made it possible for a computer program to perform tasks that have traditionally been reserved for humans (Goodwin, 1998; Magnenat-Thalmann & Kshirsagar, 2000). Historically, people have spent much effort marking the boundary between human and nonhuman, distinguishing humans from both animals and machines (Sheehan, 1991a, 1991b). However, these trends in computer animations and intelligence have made it increasingly difficult to make the human/nonhuman distinction, which we call *agency,* in virtual environments.

These trends in the use of anthropomorphic images and entities acting with intelligence in mediated systems have a practical bearing on the usability and the perception of the systems and people's sense of presence. These trends have raised two kinds of concerns: psychological concerns about the potential influence on people's ability to successfully function in the information age (Don, 1992; Laurel, 1990; Turkle, 1995), and questions about the implications of these social responses for the design of interfaces (Brooks, 2002; Cassell et al., 2000). This paper examines the influence of the visual representation as well as agency on people's sense of telepresence, copresence, and social presence. Implications of these findings for the design and use of social virtual environments are discussed. The next section defines and differentiates telepresence, copresence, and social presence.

2 The Sense of "Being There" with Another in a Social Virtual Environment: Telepresence, Copresence, and Social Presence

The concept of presence is very broad and has a variety of definitions and meanings (Barfield, Zeltzer, Sheridan, & Slater, 1995; Lombard et al., 2000). Presence has been recognized as a key performance goal for many systems and can provide insight into both the medium's ability to provide the feeling that the user is "there" inside the media (telepresence) or in the "company of others" (copresence) (Schroeder, 2002). At the same time, presence can measure the extent to which people feel that the interface is able to provide some sense of access to another mind (social presence). Presence includes several dimensions—including telepresence, social presence, and copresence—and each of these are defined and measured distinctly as outlined in this section.

The concept of mediated presence, or telepresence (Draper et al., 1998; 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). When telepresent, the user feels immersed (Witmer & Singer, 1994) in the environment represented by the medium (Steuer, 1994). Biocca (1997) and others (Gerrig, 1993; Minsky, 1980) 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 reported that they were actively perceiving others and felt that others were actively perceiving them. Further, in its true meaning, "copresence renders persons uniquely accessible, available, and subject to one another" (Goffman, 1963, p. 22). 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 (Nowak, 2001).

Social presence has been frequently used to evaluate people's ability to connect via telecommunication systems (Rice, 1993; Short et al., 1976; Walther, 1996). Short et al., (1976) are credited with giving broad theoretical currency to the concept of social presence. They defined 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 measures of social presence have been shown to relate more to the user's perception of a medium's ability to provide salience of another as opposed to mea-

suring the actual perceived salience of another person (Nowak, 2001).

This section defined telepresence, copresence, and social presence. The next section defines agency and considers its potential influence on these constructs.

3 Considering Agency: Does the Agency of a Virtual Human Influence the Level of Presence?

The philosophical and psychological concept of agency has many subtle dimensions (Bratman, 1999; McCann, 1998). The concept of agency, defined as the state of being in action or of exerting power, is central to the issue of the volitional or intentional force that drives the actions of an entity. The difference between an agent and avatar, as defined here, turns on the issue of agency. The term *agent* is used to describe an entity whose actions are controlled by the computer itself (a bot), whereas the term *avatar* is used to describe an entity whose actions are controlled by a human in real time. This project examines whether or not this distinction influences telepresence, copresence, or social presence.

There are two basic positions on the influence of agency:

- *Human primacy*: This position holds that "humanity matters" (Sheehan, 1991a and b). If this were true, then agency would affect social experience. Therefore, even if agents look and behave the same, users will feel less connected to them than they will to those who are human, or avatars.
- *Automatic social responsiveness*: This position holds that people automatically respond socially to entities that look or behave like humans. Therefore, if an agent looks or behaves like a human, people will respond to it socially, or like they would respond to another human (Reeves & Nass, 1996).

These positions define the extremes; one argues that humanity matters psychologically, the other that only the illusion of humanity matters. This experiment explores this boundary.

Daniel Dennett suggested that people have adopted a successful evolutionary strategy in dealing with all entities they encounter and treating all entities (including people, animals, and artifacts) as if it were a rational agent governed in its "choice" of "action" by a "consideration" of its "beliefs" and "desires" (Dennett, 1996, p. 27).

Consistent with the intentional stance, there is behavioral and neuropsychological evidence to suggest that humans are hardwired to respond to cues that suggest an entity has intentionality. In our encounter with intentional entities, ones that appear human may receive special attention. Agents in virtual environments may behave or appear in ways that could activate selective neuropsychological responses, which may lead to the perception that these entities are "living" as opposed to "nonliving" (Gainotti, Silveri, Daniele, & Giustolisi, 1995; Warrington & Shallice, 1984). In other words, computer-generated agents may activate people's tendency to respond socially. This may mean that people are unable or unwilling to distinguish between humans and nonhumans in the face of similar morphology and behavior (Keil, 1994).

When designing interfaces, it is important to understand the influence of agency on users' sense of presence. To understand what someone is saying, why they said it, and the social implications of the message, any interaction with another triggers people's need to determine who sent the message and why. The assumption might be, as the human primacy position argues, that agents are "mindless." If users focus on the mindlessness of agents, it is reasonable to theorize that, although they may respond socially to any entity, they will feel less copresence and socially present with these "empty" nonhuman others. It is thus likely that agency will influence the user's sense of access to another mind. This may mean varying levels of qualities that make people feel they have access to another mind will evolve, with the highest level being reserved for human minds.

This leads to the following hypotheses:

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

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

At the same time, people regularly interact with other physically present, or mediated, humans (such as via telephone or television). Users have less experience interacting in the same physical space as artificially intelligent entities and may subconsciously maintain distance from them, thus reducing the sense of telepresence in the environment. The knowledge that the intelligence is not human may lead the user to feel less telepresent in the same environment as the agent. This leads to the following hypothesis:

Hypothesis III: People will feel more telepresence interacting with an avatar than with an agent.

3.1 An Image Will Increase Presence

People interact with others in virtual environments for a variety of purposes. During these interactions, people are forming mental models of one another. Research has suggested that users continue to categorize other people in virtual environments using the same categories and similar processes to those used in unmediated environments (Lipton, 1996; Reeves & Nass, 1996; Waskul & Douglass, 1997). In the natural, unmediated world, the features of the natural body are used for categorizing and forming mental models of one another (Argyle, 1988; Ichheiser, 1970). Further, a person's physical characteristics are the basis for identification during unmediated interactions (Ichheiser, 1970). Thus, it is likely that people will use the features of the virtual image for categorization in virtual environments and that the virtual image will influence how people respond to and feel about the medium and the environment itself. Further, being represented by an image makes the people and environment seem more "real" (Taylor, 2002). It has been argued that one of the major reasons for providing visual images in virtual environments is to give users a sense of one another's presence and to enhance the feeling of colocation (Benford, Greenhalgh, Rodden, & Pycock, 2001). It seems that the visual images provide a means of identification and recognition that may enhance engagement in the environment (Benford et al., 2001; Talamo & Ligorio, 2001; Taylor, 2002).

If this were correct, then any visible representation of another would cause people to feel more immersed in the environment than when no image is visible.

This led to the following hypothesis:

Hypothesis IV: People will feel more telepresence when their partner is represented by an image than when the partner is not represented by an image.

Not only is the very existence of a virtual image likely to influence perception, but different images have been shown to have different influences (Koda, 1996; Slater & Steed, 2002; Taylor, 2002; Turkle, 1995; Wexelblat, 1997), although the direction and type of influence different images have is still unclear. People may assume that virtual images with human morphological characteristics (anthropomorphic) necessarily represent humans (Koda, 1996; Wexelblat, 1997), and less-anthropomorphic images represent nonhumans (Slater & Steed, 2002). Although people have responded socially to all interfaces to some degree (Reeves & Nass, 1996), this "social" response has appeared to be stronger with the more "human"-looking (anthropomorphic) images (Koda, 1996; Reeves & Nass, 1996; Turkle, 1995). More-anthropomorphic images have been reported to be more engaging, interesting, and attractive (Koda, 1996; Wexelblat, 1997), which may explain why much of the character design work is done with a goal towards re-creating lifelike or human-like forms (Isla & Blumberg, 2002). At the same time, more-anthropomorphic images may set up higher expectations that could be disappointing when these expectations are not met (Hindmarsh, Fraser, Heath, & Benford, 2001; Slater & Steed, 2002).

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 almost any shape (Fisher, 1997). Virtual images have been shown to represent a person and may be perceived to convey their abilities or limitations in the virtual world (Benford et al., 2001). This may have advantages or disadvantages for human communication (Lanier, 1992). It would be advantageous if, for example, shape could be altered to dynamically express a range of personalities and moods to facilitate people's ability to communicate. On the other hand, it would be disadvantageous if the shape created an expectation (such as a

level of intelligence or "humanness") that the entity behind it was unable to meet.

This ambiguity raises the question about how anthropomorphism influences the dimensions of presence. There is some evidence to support the notion that people are more comfortable with those that look most like them. First, in the person perception process, people create models of others based on what is most familiar, or based on a generalization from their own mind (Gordon, 1986). Secondly, users of low-bandwidth systems have been shown to believe that others were more "like them" than users of high-bandwidth systems where there are more indicators (such as voice and pictures) (Walter, 1996). It is likely that the image a person creates in their mind when a mediated image is not visible, a "default image," will be anthropomorphic because human morphology is most familiar.

Therefore, responses to virtual entities not represented by any image should be more similar to responses to entities represented by highly anthropomorphic rather than less-anthropomorphic images. In other words, when no visible image is provided to the user, they will imagine their interaction partner looks anthropomorphic but feel less connected to them when they're represented by a low-anthropomorphic image that doesn't look familiar.

This leads to the following hypotheses:

Hypothesis V: People will feel less copresence with partners represented by low-anthropomorphic images than with partners represented by high-anthropomorphic images or by no images.

Hypothesis VI: People will feel less social presence with partners represented by low-anthropomorphic images than with partners represented by high-anthropomorphic images or no images.

4 Method

A 2×3 between-subjects experiment was conducted using two factors: (1) agency of virtual other with two levels—(i) participants were told they were interacting with a human (avatar condition) or (ii) a bot (agent condition); and (2) degree of anthropomorphism of virtual image with three levels—(i) highly anthropomorphic image, (ii) low-anthropomorphic image, and (iii) no image control.

4.1 Participants

A total of 134 undergraduate participants (94 men, 40 women) received extra credit in introductory telecommunication courses at a large midwestern university. Participants were stratified by sex and randomly assigned to one of the six experimental conditions.

4.2 Stimulus Materials

4.2.1 The Environment. This interaction took place in a three-dimensional environment that appeared on a computer screen and resembled a meeting room and either saw an image representing their interaction partner or did not. See Figure 1.

4.2.2 Degree of Anthropomorphism. The degree of anthropomorphism was manipulated by inserting one of three types of images in a virtual room: a high-anthropomorphic image (Figure 1a), a low-anthropomorphic image (Figure 1b), or no image at all (Figure 1c). Both images included eyes and mouths.

4.2.3 Agency. Both written and verbal instructions contained the agency manipulation. Participants were told whether they were interacting with either a human-controlled avatar or a computer-controlled agent.

4.3 Measurement Instruments[1]

4.3.1 Telepresence. Telepresence 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 as immersion (Lombard & Ditton, 1999). Eight

1. Confirmatory factor analysis and tests of internal consistency were applied to each scale. All items loaded highest on their primary factor. The final number of items in each scale and standardized item alpha is presented in Table 1.

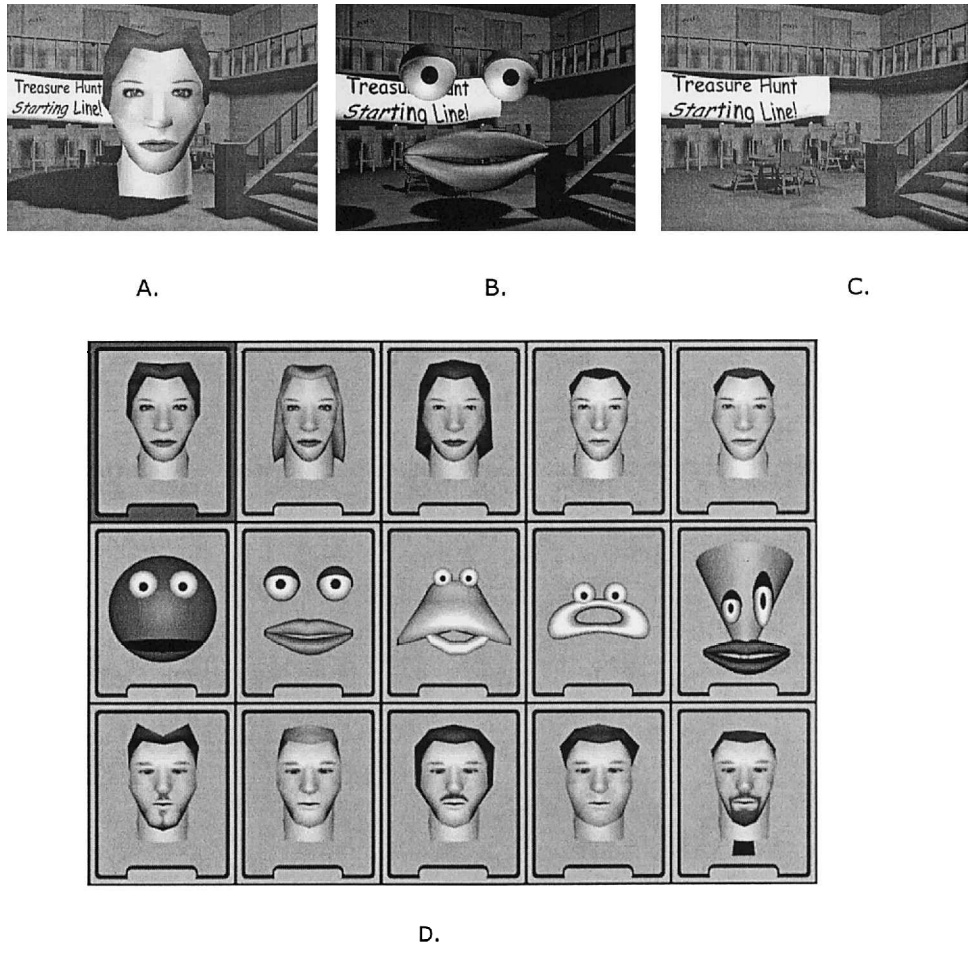

Figure 1. *Images of the different images used in experimental conditions of this study: (a) high-anthropomorphic image, (b) low-anthropomorphic image, and (c) no image. Figure 1 (d) In either the high-anthropomorphic or low-anthropomorphic conditions, participants were allowed to select one of these characters on the "Virtual Representation Selection Screen" to represent them.*

Likert-type items with a seven-point metric were used to form a scale. (See Table 1 for retained items.)

4.3.2 Copresence. Copresence is related to the feeling of connection between two people. Given its dual nature, this was measured by two separate scales, one asked about participants' perception of their partner's involvement in the interaction (perceived other's copresence) and the other asked them to self-report about their involvement in the interaction (self-reported copresence).

The *perceived other's copresence* scale included fifteen indicators. This scale was derived from a combination of the indicators for intimacy, involvement, and immediacy (Burgoon & Hale, 1987). (See Table 1 for retained items.)

The *self-reported copresence* scale included eleven of the items used in perceived other's copresence, but revised to ask the participants to self-report their level of involvement in the interaction. (See Table 1 for retained items.)

4.3.3 Social Presence. Social presence, or the perceived ability of the medium to connect people, con-

Table 1. *Items Retained and Used as Measurement Instruments*

Dependent Variable	Items retained after tests of internal consistency and reliability
Self-reported copresence. (Standard alpha. 78). 1–5 strongly agree, strongly disagree.	I did not want a deeper relationship with my interaction partner.
	I wanted to maintain a sense of distance between us.
	I was unwilling to share personal information with my interaction partner.
	I wanted to make the conversation more intimate.
	I tried to create a sense of closeness between us.
	I was interested in talking to my interaction partner.
Perceived other's copresence. (Standard alpha. 9). 1–5 strongly agree, strongly disagree.	My interaction partner was intensely involved in our interaction.
	My interaction partner seemed to find our interaction stimulating.
	My interaction partner communicated coldness rather than warmth.
	My interaction partner created a sense of distance between us.
	My interaction partner seemed detached during our interaction.
	My interaction partner was unwilling to share personal information with me.
	My interaction partner made our conversation seem intimate.
	My interaction partner created a sense of distance between us.
	My interaction partner created a sense of closeness between us.
	My interaction partner acted bored by our conversation.
	My interaction partner was interested in talking to me.
	My interaction partner showed enthusiasm while talking to me.
Telepresence scale. (Standard alpha .88) 1–7, Not at All, Very Much	How involving was the experience?
	How intense was the experience?
	To what extent did you feel like you were inside the environment you saw/heard?
	To what extent did you feel immersed in the environment you saw/heard?
	To what extent did you feel surrounded by the environment you saw/heard?
Social presence: (Standard alpha .82). Sliding scale	To what extent did you feel able to assess your partner's reactions to what you said?—Able to assess reactions, not able to assess reactions.
	To what extent was this like a face-to-face meeting?—A lot like face to face, not like face to face at all.
	To what extent was this like you were in the same room with your partner?—A lot like being in the same room, not like being in the same room at all.
	To what extent did your partner seem "real"?—Very real, not real at all.
	How likely is it that you would choose to use this system of interaction for a meeting in which you wanted to persuade others of something?—Very likely, not likely at all.
	To what extent did you feel you could get to know someone that you met only through this system?—Very well, not at all.

sisted of nine items from Short et al. (1976). Participants used a sliding scale to indicate social presence. This sliding scale coded participants' placement of the slider on the screen, using a mouse, to the nearest hundredth. (See Table 1 for retained items.)

4.4 Procedure

Participants completed a consent form and pretest questionnaire measuring demographics and computer usage. Participants were given written instructions that told them that their goal was to get to know their partner who may work with them and compete as a team for a $100 prize in the future on a scavenger hunt for software technologies on the World Wide Web. The participants were given additional instructions and then sat at a 19 in. computer screen equipped with headphones, a microphone, and a keyboard, which they used to enter the virtual environment.

In the no-image condition, the participants entered their participant ID numbers and immediately entered the virtual room (Figure 1c). In the other conditions, participants entered the ID numbers and went to the character selection screen (Figure 1d) where they selected an image to represent them. Then participants entered the virtual environment by pressing the enter key.

The average interaction lasted about 15 min. The interaction began with the virtual confederate (agent or avatar) introducing himself or herself. When the virtual confederate was done, the participant saw a green light indicating it was their turn. The participant spoke into a microphone to give their name and other introductory information. Following their introduction, the participant pressed a button marked "done" to indicate their turn was over, and the green light went off. Then, the virtual confederate indicated their skills relevant to a scavenger hunt on the World Wide Web. All participants in all conditions heard the same prerecorded female voice reading the same script. When the virtual confederate was finished, the participant again saw a green light indicating that it was their turn to summarize their skills and again press the "done" button when finished. The virtual confederate said goodbye and indicated a wish to continue working with the participant, and the green light came on again, allowing the participant to say goodbye. When the participant indicated they were done saying goodbye, the interaction was over.

After the interaction, participants completed an online questionnaire that included measures of presence, copresence, and social presence. Then they were debriefed.

5 Results

A linear regression with effects coding (1, agency; 2, avatar) was conducted on Agency for Hypotheses I–III. Effects-coded regressions were also run to compare those who interacted with a partner represented by a virtual image (either high- or low-anthropomorphic) to those who interacted with a partner not represented by a virtual image on telepresence (hypothesis IV), and to examine the influence of the different images on copresence (hypothesis V) and social presence (hypothesis VI). The agent variable was effect coded, and a regression was run to look for multiplicative interaction, but none was found. (See Table 2.)

5.1 Effect of Agency on Presence

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

This hypothesis was not supported.

The effect of agency on perceived other's copresence is not significant: $R = .03$, $F = .15$, $p = .7$. Participants did not perceive more copresence with an avatar (M = 3.13, SD = .78) than with an agent (M = 3.17, SD = .77).

The effect of agency on self-reported copresence is not significant: $R = .05$, $F = .33$, $p = .57$. Participants did not feel more copresence with an avatar (M = 3.18, SD = .80) than with an agent (M = 3.10, SD = .69).

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

The effect of agency on social presence is not significant: $R = .09$, $F = .96$, $p = .33$. Participants did not feel more social presence with an avatar (M = 1.40, SD = .33), than with an agent (M = 1.45, SD = .33).

Table 2. *Summary of Linear Regression Analysis with Effects-Coded Values for Tests of all Hypotheses*

Variable	Effects coding	B	SE B	β
HIa: Agency on perceived other's copresence	1 agent, 2 avatar	−.00	.13	−.034
HIb: Agency on self-reported copresence	1 agent, 2 avatar	.00	.13	
HII: Agency on social presence	1 agent, 2 avatar	.00	.06	−.09
HIII: Agency on telepresence	1 agent, 2 avatar	−.15	.20	−.06
HIV: Virtual image on telepresence	−1: no image; 0: high-anthropomorphic image; 1: high-anthropomorphic image	.25	.13	.17*
HVa: Virtual image on perceived other's copresence	−1: low-anthropomorphic image; 1: anthropomorphic image; 0: no image	.20	.08	.22*
HVb: Virtual image on self-reported copresence	−1: low-anthropomorphic image; 1: anthropomorphic image; 0: no image	−.16	.08	.17*
HVI: Virtual image on social presence	−1: low-anthropomorphic image; 1: anthropomorphic image; 0: no image	.00	.03	−.19*

$p < .05$.

Hypothesis III: People will feel more telepresence interacting with an avatar than with an agent.

This hypothesis was not supported.

The effect of agency on telepresence was not significant: $R = .06$, $F = .55$, $p = .46$. Participants did not feel more telepresence when interacting with an avatar (M = 3.37, SD = 1.21) than with an agent (M = 3.52, SD = 1.15).

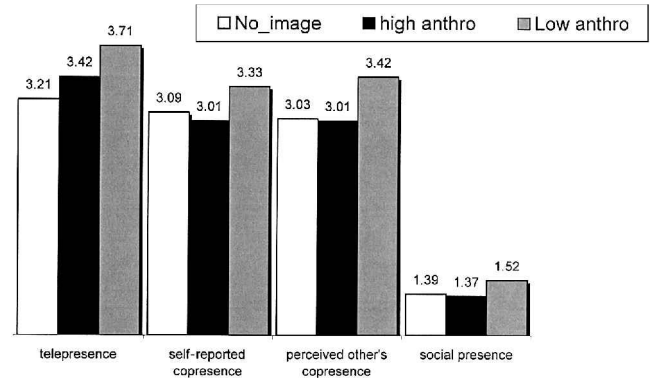

Figure 2. *Means for no-image, high-anthropomorphic image, and low-anthropomorphic image reported by dependent variables telepresence, self-reported copresence, perceived other's copresence, and social presence.*

5.2 Effect of Virtual Image on Presence

Hypothesis IV: People will feel more telepresence when their partner is represented by an image than when the partner is not represented by an image.

A linear regression with effects-coded values to compare the no-image condition to the image conditions combined (0: no image; 1: anthropomorphic image or low-anthropomorphic image) was used to test this hypothesis. Although those in the image conditions felt more presence than did those in the no-image condition, the difference was not significant: $R = .14$, $F = 2.48$, $p = .12$.

However, as seen in Figure 2, people did report higher levels of telepresence when they interacted with a partner represented by an image. However, contrary to predictions (but consistent with other measures of presence), participants reported more telepresence with the low-anthropomorphic image than with the anthropomorphic image. This linear relationship was tested with a linear regression with effects-coded values (−1: no

image; 0: anthropomorphic image; +1: low-anthropomorphic image). This relationship is significant: $R = .17$, $F = 3.87$, $p = .05$. Those in the low-anthropomorphic condition felt more telepresence than those in the anthropomorphic condition, who felt more telepresence than did those in the no-image condition.

5.3 Effect of Less-Anthropomorphic Image on Copresence and Social Presence

A linear regression with effects coding to test the prediction that those in the less anthropomorphic condition would have less social and copresence than those in the no-image condition, who would have less social and copresence than those in the high anthropomorphic condition (−1: low-anthropomorphic image; 0: no image; 1: high-anthropomorphic image) was used to test hypotheses V and VI. (See Table 2. See means by condition in Figure 2.)

Hypothesis V: People will feel less copresence with partners represented by low-anthropomorphic images than with partners represented by high-anthropomorphic images or by no images.

This hypothesis was not supported. The effect of the low-anthropomorphic image was significant in the opposite direction.

The effect of an anthropomorphic virtual image on perceived other's copresence is significant: $R = .22$, $F = 6.52$, $p = .01$. Participants interacting with the less anthropomorphic virtual image reported their partners to be more copresent than those who interacted with either a more anthropomorphic virtual image or with no image.

The same trend in the results was found with regard to the participants' self-reported copresence in the interaction. The effect of a low-anthropomorphic image on participants' self-reported copresence is significant: $R = .18$, $F = 4.23$, $p = .04$. Participants interacting with a less-anthropomorphic virtual image felt more copresence with their partner than did those interacting with either no image or with a more anthropomorphic virtual image.

Hypothesis VI: People will feel less social presence with partners represented by low-anthropomorphic images than with partners represented by high-anthropomorphic images or no images.

This hypothesis was not supported. There was a significant difference in the opposite direction.

The effect of a low-anthropomorphic image on participants' social presence is significant: $R = .19$, $F = 4.90$, $p = .03$. Participants interacting with a less anthropomorphic virtual image felt that the environment could provide more social presence than did those interacting with either no image or with a more anthropomorphic virtual image.

6 Discussion

The results have implications for various theoretical issues regarding mediated interactions. We now consider the implications of the results just presented in terms of the influence of agency and the virtual image on presence, copresence, and social presence. Then we discuss implications for virtual environment design and use.

6.1 Agency Does Not Influence Presence

There was no difference in participants' 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 participants felt physically present in the virtual world (telepresence). Given that the means in all conditions were well above the middle of the scale (representing relatively high levels of presence), it seems that users felt they had access to another mind and that the mind was attending to them and that they felt present in the virtual environment regardless of whether they interacted with an agent or avatar.

Although no real conclusions can be made with nonsignificant differences, these results are consistent with several other studies that suggest that participants respond to computers socially, or in ways that are similar to their responses to other humans (Reeves & 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 nonhuman.

6.2 Increasing Telepresence: Any Image is Better Than No Image

The results show that when people interacted with a partner represented by any visible image, they felt more immersed in the virtual environment (presence) than when there was no visible image. This was true regardless of whether their partner was an agent or an avatar. At the same time, although those in the no-image condition felt less telepresence than those in either image condition, when it comes to a sense of connection with another entity, the choice of image is influential as well as explored in the next section.

6.3 Appearance Matters: Pick Your Image Carefully

A pioneer of virtual reality technology, Jaron Lanier, suggested that users could easily "become a lobster" or to take on any image (Lanier, 1992). The results reported previously indicate that taking advantage of this freedom to be anybody may have consequences. When the virtual human's image was more unusual and iconic (less anthropomorphic), people felt more copresence, social presence, and telepresence. In this case, users may have felt more excited, engaged, and interested when the image deviated from what they have experienced in the physical world. These results conflict with previous research that indicated that anthropomorphism increased people's level of engagement (Koda, 1996; Wexelblat, 1997). It appears that there are consequences to one's choice of images, although which features or characteristics of the image increase engagement is still unknown.

It is possible that the more anthropomorphic image in this experiment brought about higher expectations that were not met (Hindmarsh et al., 2001; Slater & Steed, 2002). In open-ended questionnaires, some participants reported feeling strange about interacting with a head floating without a body. It is possible that this had more of an influence in the more anthropomorphic condition in which some participants mentioned that the human-like choices were "not very attractive" and "funny looking." At the same time, the mouth and eyes were much larger in the low anthropomorphic condition, which may have increased engagement. Further research is needed to clarify what features or characteristics of the image cause increased engagement and presence.

6.4 A Case for an Anthropomorphic "Default Image"

There was no significant difference in the sense of copresence and social presence between users who interacted with a high anthropomorphic image and those who interacted with someone not represented by an image (although there was a significant difference in telepresence). This indicates that the high-anthropomorphic image was more similar to the mental image participants created in their minds, or the default image when there was no visible image. This is consistent with the prediction that, in the absence of contradictory information, people assume that their interaction partner is anthropomorphic. It is important to note that the reaction to the anthropomorphic virtual image was not negative, but instead that reactions to the low-anthropomorphic image were more positive.[2] This is consistent with both the argument that people's model of the other's mind is based on a generalization from one's own mind (Gordon, 1986) as well as Walter's 1996 finding that users were more likely to believe that others were "like them" in low bandwidth systems than in high bandwidth systems. Both of these theories argue that there may be a tendency for the "default other" to be some variation on the self in the absence of disconfirming experience.

7 Conclusion: Any "Other" Increases Presence, but All Bodies are Not Equal

It has been argued that people may tend to respond socially to all intelligent others, whether the others are human or not (Reeves & Nass, 1996). The re-

2. See Figure 2. The means for all conditions were above the middle of the scale.

sults from this study are consistent with this theory, but they must be interpreted cautiously as they are based on acceptance of the null hypothesis. There were no differences in users' sense of presence whether or not they were interacting with a human, but all users felt a relatively high degree of presence.

At the same time, the results showing significant differences in how people responded to virtual bodies suggest a caveat. The presence of a virtual body caused people to feel more telepresence or immersion in the virtual environment. Also, certain types of images enhanced or increased both presence and social presence. Anthropomorphic virtual bodies with human voices may consistently elicit social responses, but, at a certain level, increasing anthropomorphism may be less important to presence than exaggerating certain features of the image to enhance the experience. Also, increasing anthropomorphism may raise expectations and should be done only when the interface and system can meet higher expectations.

Participants were engaged with virtual humans whether they looked human or not. There is support in this experiment for the following conclusions: as artificial entities are represented by images or use language like humans, then they may elicit automatic social responses from users. If they enhance facial expression and features or are unique and interesting, these responses may be increased. The visible representation had an effect on presence, but the perception of whether the other was human or not had no effect. Future research should work to better define the boundaries of when, where, and how these responses are evoked.

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