Who´s there? Can a Virtual Agent Really Elicit Social Presence?

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Abstract

This study investigates whether humans perceive a higher degree of social presence when interacting with an animated character that displays natural as opposed to no listening behaviors and whether this interacts with people's believe that they are interacting with an agent or an avatar. In a 2x2 between subjects experimental design 83 participants were either made believe that they encounter an agent, or that they communicate with another participant mediated by an avatar. In fact, in both conditions the communication partner was an autonomous agent that either exhibited high or low behavioral realism. We found that participants experienced equal amounts of presence, regardless of interacting with an agent or an avatar. Behavioral realism, however, had an impact on the subjective feeling of presence: people confronted with a character displaying high behavioral realism reported a higher degree of mutual awareness.

Keywords---**virtual agents, avatars, social presence, experimental study, behavioral realism**

1. Introduction

Lombard and Ditton define presence as "the perceptual illusion of nonmediation" [1, p.1]. They state that "[this] illusion of nonmediation occurs when a person fails to perceive or acknowledge the existence of a medium in his/her communication environment and responds as he/she would if the medium were not there. [1, p.1]" Although this definition was originally targeted at presence in a general sense, it is also true for social presence. For instance, it describes that two human beings who interact with each other via a chat- or VOIP-system or in a virtual environment forget about the mediation and experience the situation as they would in a face-to-face setting. While this has been demonstrated in several studies [e.g. 2] it is still an open question of whether one has to assume that the interaction partner is another human being in order to develop this feeling of social presence. In fact, in today´s virtual environments (see e.g. Second life) not every interaction partner is a mediated human being but can also be a bot, i.e. an autonomous computer program. Against this background it might be asked whether the knowledge of whether one interacts with a medium (an avatar which represents a human being) or with a source (an autonomous virtual agent) makes a difference with respect to the degree of social presence experienced (see the distinction between medium and source by [3]).

Embodied Conversational Agents (ECAs, but also characters in computer games) represent examples of this category of being a source instead of a mediated human being. In "The Media Equation", Byron Reeves and Clifford Nass present a series of studies that all result in the same conclusion [4]: people respond automatically in a social and natural way to computers. They treat computers as social entities, because they use natural language, interact in real-time, and fill traditional social roles. Embodied conversational agents provide even more social signals such as humanlike appearance and nonverbal behavior and should thus be expected to evoke even more social reactions. In fact, numerous studies show that people mindlessly apply their repertoire of social rules and reactions [5, 6, 7, 8, 9, 10, for an overview see 11] - although they consciously know that they are not interacting with a human being and even state that they think that the agent does not warrant social reactions.

With regard to the experience of social presence it remains to be asked whether also the subjective feeling of social presence is the same when interacting with an agent or an avatar. Do people who know that they are interacting with an autonomous machine experience the same level of social presence as people who know that they are interacting with an avatar, i.e. a mediated human being?

In their "Threshold Model of Social Influence" Blascovich et al. [12, 13] state that the social presence of real a person will always be high, whereas the social presence of an artificial entity depends on the realism of its behavior. However, when reading the concepts carefully, it becomes clear that social presence in this context means social influence and is measured via behavior instead of subjective feelings of presence. However, additional studies by Bailenson et al. have also targeted the experience of social presence when interacting with either avatars or agents. They found that participants within an immersive virtual environment experienced more social presence when they believed they were interacting with an avatar rather than

when they thought they were interacting with a computer agent. In addition, in this study behavioral realism seems to have an effect, as participants in the high behavioral realism group reported more feelings of social presence than participants in the low behavioral realism group [14].

However, these findings have not been demonstrated consistently: Nowak and Biocca [15] also manipulated agency (alongside the degree of anthropomorphism). They found no main effect for agency on co-presence, social presence or tele-presence: People interacting with an agent had neither less nor more feelings of social presence as people interacting with an avatar. They concluded, however, that this cannot yet be seen as a proof of the notion that the conditions can be considered as equal.

Thus, merely a few studies in this realm have explicitly targeted the concept of social presence as it has been discussed and developed within the social presence community: Originally conceptualized as a property of a communication medium to increase, "…the degree of salience of the other people in the interaction" [16, p.65], social presence has been developed into a psychological variable reflecting the subjective experience of closeness and connectedness in mediated communications [17, 18, 19]. Biocca, Harms, and Burgoon [20] define social presence as, "the moment-by-moment awareness of the co-presence of another sentient being accompanied by a sense of engagement with the other" (p. 2) and consider this awareness as a key variable for the success of a medium across all application domains. Social presence is seen as varying on a continuum, reaching from the peripheral sense of spatial co-presence to progressively higher levels of psychological involvement. This continuum gives access to the intentional, cognitive, and affective states of the other. Higher levels of social presence include a sense of behavioral engagement, which is expected to lead to actions that are perceived as linked, reactive, and interdependent [20]. Social presence is theoretically as well as within a questionnaire conceptualized as a multidimensional construct including co-presence, mutual comprehension, emotional closeness, social relatedness, and behavioral contingency [21, 22].

Given this, we opted to include social presence as measured by the networked minds questionnaire as dependent variable in our study on the differential effects of avatars and agents. We were interested in testing whether humans perceive a higher degree of presence when interacting with an animated character displaying natural, as opposed to no, listening behaviors and whether this interacts with the knowledge of interacting either with an agent or an avatar. The factors that are varied in the study are a) the instruction with regard to the nature of the artificial character (agent vs. avatar) as well as b) the behavioral realism (high behavioral realism vs. low behavioral realism). The design of the study allows us to examine whether the experience of social presence is triggered by situations as soon as they include social cues (according to the ethopoeia concept suggested by [4]) or whether social presence will more likely occur when the virtual character is thought to be a virtual representation of a real person rather than an artificial entity (as proposed in the "Threshold Model of Social Influence" provided by [13, 14]).

The results will on the one hand allow to draw conclusions on the differences between the reactions towards avatars and agents (and thus the social nature of humans). On the other hand it will also provide further insights on the concept of social presence.

2. Experimental Design

A 2 x 2 between-subjects-design with the following conditions was chosen:

	Agent	Avatar
High behavioral realism	N = 21	N = 22
Low behavioral Realism	N = 20	N = 20

Participants were randomly assigned to the conditions.

2.1. Factor Agency

For the factor agency we varied the instruction given to the participants by the experimenter. Although, in fact, all participants interacted with the Rapport Agent, a virtual agent which displays listening behavior according to the nonverbal behavior and the speech of the participants, half of them were led to believe that they interacted with an avatar and half of them were instructed that they interact with an agent. Thereby, we could guarantee that all participants experienced the same treatment and we avoided biases resulting from different participants or confederates.

2.1.1. Instruction Avatar: The instruction in the avatar condition was: "We invited two participants for this experiment to test this new communication system. You will see an animated character on this screen. The animated character will copy the head and body movements of another participant who is sitting in another room. For example, if the other person nods his or her head, the animated character will nod its head. The other participant will also see an animated character on the screen which represents you. Both of you have a red camera in front of you which tracks your head and body movement. The other participant is instructed to ask you three given questions about your daily life and then listen to your answer. Please only respond to the questions and don´t ask questions yourself, because the other participant is instructed not to answer. You have as much time as you want for answering the questions. When you are finished with answering the three questions please return to the monitor next to the door and start the second part of the questionnaire. I have to check with my fellow experimenter who looks after

the other person whether they are ready to start the experiment. (Experimenter left room for a minute). Okay they are ready to start. You can now go around the desks to the other monitor, sit down and don the headset. Wait until the other participant says “I´m ready”.”

2.1.2. Instruction Agent: The instruction in the agent condition was: “In the second part of the experiment you will see an animated character on this screen. The animated character is computer generated. It looks and behaves humanlike, but in fact it is a software program. The animated character can see your head and body movements via the red camera in front of the screen. It can hear what you are saying via the microphone. And you can hear the animated character through the headset. The animated character will ask you three questions about your daily life and then listen to your answer. Please only respond to the questions and don´t ask questions yourself. In this experiment we are focusing on one-way communication: you are telling a story and the animated character is listening. You have as much time as you want for answering the questions. You can go around the desks now to the other monitor, sit down and don the headset. Wait until the animated character says “I´m ready”.”

2.2. Factor Behavioral Realism

For the study, we used the Rapport Agent which has been developed by Gratch et al. [23] and displays listening behaviors that correspond to the verbal and nonverbal behavior of a human speaker. The Rapport Agent was evaluated in several studies [23, 24, 25, 26, 27] and it was shown that the system is able to create the experience of rapport comparable with a face-to-face condition. For this study we used the Rapport Agent with some adjustments described below in detail.

2.2.1 Rapport Agent. To produce listening behaviors, the Rapport Agent first collects and analyzes the features from the speaker’s voice and upper-body movements via microphone and a Videre Design Small Vision System stereo camera which was placed in front of the participants to capture their movements. Watson, an image-based tracking library developed by Louis-Phillipe Morency [28], uses images captured by the stereo camera to track the subjects’ head position and orientation. Watson also incorporates learned motion classifiers that detect head nods and shakes from a vector of head velocities. Acoustic features are derived from properties of the pitch and intensity of the speech signal using a signal processing package, LAUN, developed by Mathieu Morales [23]. The animated agent was displayed on a 30-inch Apple display. A female virtual character was used in all conditions (see figure 1).

Figure 1 The Rapport Agent

Adjustments: Usually, the Rapport Agent displays behaviors that show that the animated character is “alive” (eye blinking, breathing), and listening behaviors such as posture shifts and head nods (the agent only supports a single short head nod) automatically triggered by the system according to participants´ verbal and nonverbal behavior.

For this study, however, we modified the system so that it was possible to conduct a small dialogue. The rapport agent still acts as a listener but prompts the participant´s narration by several questions. Before the interaction starts, the animated character is looking to the ground to avoid eye contact with the participant before the system starts. When the system starts, indicated by the ping-sound, the animated character looks up and says “Okay, I´m ready.” We did not use a text-to-speech-system, but prerecorded five sentences with a female voice instead to create the illusion that there might really be another participant in another room. The sentences were the following:

- Okay, I´m ready.
- What has been the most special experience for you yesterday?
- What characteristics of yourself are you most proud of?
- What has been the biggest disappointment in your life?
- Thank you. You´re done.

We programmed two different kinds of head nods, a double head nod with higher velocity and smaller amplitude (called backchannel head nod) and a single head nod with lower velocity and bigger amplitude (called understanding head nod). The single head nod was used as back-channeling head nod and replaced the head nod normally used by the Rapport Agent. The single head nod was triggered manually at the end of the participants´ verbal contribution to one of the three questions to support the impression of an attentive listener. We also programmed a head shake to be able to react to questions appropriately, e.g. “Are you fake?” or “Are you stupid?” in the high realism condition. Fortunately, no such situation occurred and the head shake was not used in the study. The head shake, the two head nods and the five pre-recorded utterances were implemented in an interface

(see figure 2) by which the experimenter could manually actuate every behavior. In fact, we only used the pre-recorded utterances and the single head nod.

2.2.2. Low behavioral realism. For this condition we chose to use the breathing, eye blinking, and posture shifts, but no head nods, neither double head nod, nor single head nod. By this we achieved a rather unrealistic behavior, because the Rapport Agent was just staring at the participants and did not react to their contributions at all.

2.2.2. High behavioral realism. For this condition we used breathing, eye blinking, posture shifts and the two kinds of head nods. The back-channeling head nod was triggered automatically by the system according to the nonverbal and verbal behavior of the participants. The understanding head nod was actuated by the experimenter each time the participant finished his or her contribution to one of the three questions.

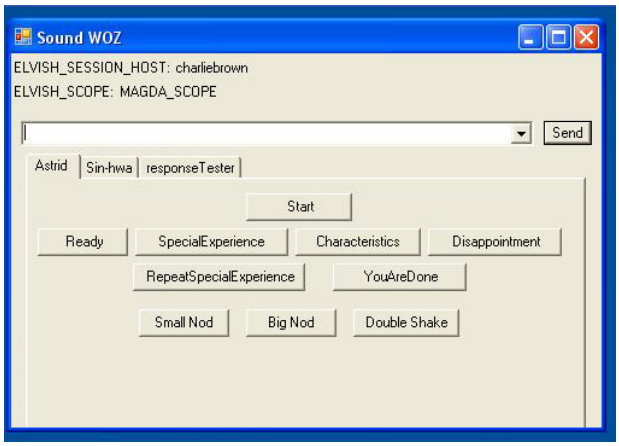

Figure 2 The Rapport Agent

2.3. Participants

Eighty-three persons, 42 females and 41 males, participated in the study. The mean age was 37.27 (sd=13.61), ranging from 18 to 65 years. Participants were recruited via www.craigslists.com from the general Los Angeles area and were compensated $20 for one hour of their participation.

2.4. Procedure

Upon arrival, the participants were asked to read Informed Consent. After completing a web-based questionnaire about their background, participants got a short introduction about the equipment and received the instruction about their interaction partner and the task of the experiment. Then participants took place in front of a 30'' screen which displayed the Rapport Agent. They were equipped with a headset with microphone. In order to assess the participants' verbal and nonverbal behavior, the whole session was video-taped. The camera was directed towards the participants and situated directly under the screen with the Rapport Agent in combination with the stereovision camera. Participants were instructed to wait until the systems starts, indicating readiness by a ping-sound. They were asked three questions by the Rapport Agent with increasing intimacy.

After the interaction, the participants completed the second web-based questionnaire. They were fully debriefed, handed $20 and thanked for their participation.

2.4 Questionnaires

In the present study we used the Social Presence Scale by Bailenson, Blascovich, & Beall [8], consisting of five items rated on a 7-point scale, measuring social presence as a single dimension concept. In addition, we used items from the Networked Mind Questionnaire [20, 29, 30]. The Networked Mind Questionnaire consists of three factors including different sub-aspects:

- Co- presence: Isolation/Inclusion (2 items) and Mutual Awareness (6 items)
- Psychological involvement: Mutual Attention (8 items), Empathy (6 items), Mutual Understanding (6 items)
- Behavioral engagement: Behavioral Interaction (6 items), Mutual Assistance (4 items), Dependent Action (2 items)

Due to a very long post-questionnaire, we did not use the whole Networked Minds Questionnaire. We concentrated on the following six aspects: Empathy (with 4 items), Mutual Awareness (with 2 Items), Attention Allocation (with 4 items), Mutual Understanding (with 3 items) and Behavioral Interdependence (with 4 items) representing all three factors, but to a smaller extent than the original questionnaire. All items from both scales were rated on a 7-point Likert scale.

3. Results

The subjective perception of social presence was measured by the (Social) *Presence Scale* and the aspects Attention Allocation, Behavioral Interdependence, Mutual Understanding, Empathy and Mutual Awareness (with negative loading) of the *Networked Mind Scale*. Although we shortened the number of items in the Networked Minds Scale we used the aspects as given by Biocca and Harms [29] and calculated mean values for the items corresponding to the different aspects.

In general, Attention Allocation (mean= 4,78; sd=1,02) and Mutual Understanding (mean=4,39; sd=1,20) received rather high scores in the rating. Subjects had the feeling that they paid attention to the Rapport Agent and that the Rapport Agent was attentive towards them. They also had rather the feeling that there was a reciprocal understanding. Mutual Awareness received lower scores (mean= 3,98; sd=1,44) but on average the participants were rather aware of their

interaction partner. They rather did not have the feeling that their emotions (Empathy; mean=3,30; sd=1,16) and actions (Behavioral Interdependence; mean=3,92; sd= 1,33) depend on the emotions and actions of their interaction partner and vice versa. Also, participants rated their feeling of social presence below average on the Bailenson Presence Scale (mean=3,79; sd=1,33).

A multivariate analysis of variance with the independent variables agency and behavioral realism revealed no effect for agency. With regard to behavioral realism, however, a significant main effect on the dependent variable Mutual Awareness emerged. The feeling of mutual awareness of the interaction partners was more intense in the condition with *high behavioral realism* rather than in the condition with *low behavioral realism* (please note that Mutual Awareness is loaded negatively and a lower mean value is associated with a higher feeling of mutual awareness; $F(1;83)= 4.548$; $p= .035$; partial $eta^2= .055$). There were no significant results for the other aspects of social presence (Mutual Understanding, Behavioral Interdependence, Empathy, Attention Allocation and the Bailenson Presence Scale). Also, no interaction of behavioral realism and agency was observed.

	High realism		**Low realism**					
Mutual	**μ**	**s**	**μ**	**s**	**F**	**df**	**η^2**	**p**
Awareness	3,670	1,553	4,334	1,242	4.548	1	.055	.035

4. Discussion

We could show that participants reported an above average feeling of presence in all conditions with regard to Attention Allocation, Mutual Understanding and Mutual Awareness. Participants had the feeling that they paid attention to the Rapport Agent and that the Rapport Agent was attentive towards them; that there was a reciprocal understanding and that they were aware of another person within the setting. There was no main effect for the factor agency. The extent of perceived presence of the agent equals the perceived presence of the avatar over all constructs, even though the participants were explicitly instructed they would interact with a computer program in the agent condition. This indicates that the explicit knowledge of interacting either with an agent or an avatar does not have an effect on the perception of presence and that presence can occur in the absence of a human being which supports the ethopoeia and Media Equation concept by Nass and Moon.

What has an influence, on the other hand, is the behavior of the virtual character: realism of the behavior has an impact on the amount of perceived presence, regardless of whether an avatar or an agent exhibits realistic behavior. Thus, high behavioral realism supports the feeling of Mutual Awareness.

Conclusions

Our study aimed to answer the question: Can an agent really elicit social presence? The results indicate that it does not matter whom participants are interacting with. Agents and avatars equally elicit feelings of presence in the user. Behavioral realism on the other side seems to have an impact. The more rich and realistic the behavior is and the more information can be obtained about the (virtual) other, the more presence is experienced.

Some limitations of this study should be considered. As mentioned above social influence is often measured via behavior instead of subjective feelings of presence. The videotaped sessions should be analyzed further with regard to the verbal and nonverbal behavior of the participants to see whether the same effects, or absence of effects, can be found on the side of behavioral measurements. Furthermore, the interaction mode in this study was very limited. We only employed a one-way communication setting in which the participant did not receive any verbal feedback on his or her verbal contributions. This was necessary to guarantee that every participant received the same treatment and that different verbal agent feedback would not affect the reliability of the study. Further research should therefore step by step include more types of feedback, verbal as well as nonverbal, to systematically investigate the effects of different degrees of feedback and behavioral realism respectively.

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APPENDIX

Social Presence, Bailenson et al. (2000x)

1. I perceive that I am in the presence of another person in the room with me.
2. I feel that the person in the room is watching me and is aware of my presence.
3. The thought that the person is not a real person crosses my mind often.
4. The person appears to be sentient, conscious, and alive to me.
5. I perceive the person as being only a computerized image, not as a real person.

Networked Mind Questionnaire

1. I hardly noticed another individual. (Mutual Awareness)
2. My actions were dependent on the other's actions. (Behavioral Interdependence)
3. I sometimes pretended to pay attention to the other individual. (Attention Allocation)
4. My thoughts were clear to my partner. (Mutual Understanding)
5. I paid close attention to the other individual. (Attention Allocation)
6. When the other was happy, I was happy. (Empathy)
7. The other individual was influenced by my moods. (Empathy)
8. My behavior was in direct response to the other's behavior. (Behavioral Interdependence)
9. When I was happy, the other was happy. (Empathy)
10. My opinions were clear to the other. (Mutual Understanding)
11. The other individual paid close attention to me. (Attention Allocation)
12. The other individual didn't notice me in the room. (Mutual Awareness)
13. I was influenced by my partner's moods. (Empathy)
14. The other understood what I meant. (Mutual Understanding)
15. The other's actions were dependent on my actions. (Behavioral Interdependence)
16. The other individual sometimes pretended to pay attention to me. (Attention Allocation)
17. The behavior of the other was I direct response to my behavior. (Behavioral Interdependence)