

Analyzing How Social Agents Influence Interpersonal Communication

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Abstract: We conducted two experiments to analyze the influence of our social agent on interpersonal communication. In the first experiment, the agent supported cross-cultural communication. The agent's behavior influenced people's impressions of the agent and their conversation partners. In the second experiment, the agent tried to control human relations. The agent's attitude influenced subjects' sentiment toward the agent, and their relations.

Keywords: Social agents, interpersonal communication, virtual space, cross-cultural communication, balance theory.

1. Introduction

Virtual spaces make it easy to have casual meetings between strangers from across town, or even across the world. Unfortunately, virtual meeting spaces usually provide little socially meaningful context to use as a basis for finding common ground with each other. Since it is easy to arrive at a virtual meeting space from many entry points, it is often hard for visitors to assume much about one another's cultural backgrounds, group memberships, and other aspects of social identity. People need this sort of common context in order to build new human relationships¹⁾.

We believe software agents could help in forming social relationships and building common ground between visitors to virtual spaces. Software agents that communicate with human users in virtual worlds have been emerging. Some of them provide social services such as conversation in text-chat worlds, and these agents are becoming vital inhabitants of virtual worlds by playing a key role in forming online communities²⁾. We call these software agents social agents. In contrast to interface agents that support human-computer interaction, social agents support interpersonal communication. We focus on agents that enter human communities such as virtual worlds, not on the typical situation where an agent interacts with a single user. We developed a social agent playing a role of party host. Our social agent conducts a series of yes/no questions to people to draw shared or conflicted points. The agent acts in the virtual space called FreeWalk developed by us³⁾.

Previous studies have demonstrated some benefits of interface agents in one-on-one task settings, such as taking an educational tutorial⁴⁾, going on a tour⁵⁾, or looking at real estate⁶⁾. These agents interact with a single user. There are projects, which have created agent-based social support through text-based conversation. Julia⁷⁾ plays a role of a

guide in virtual worlds of MUD. The Extempo bartender agent converses with visitors, and is designed to enhance the social atmosphere⁸⁾. These agents are designed to engage in one-on-one social interactions, rather than facilitating interpersonal communication. There are few studies about agents, which interact with multiple people.

The social agent we developed differs from the agents described above, which support specific tasks or play a role of a conversation partner. Our agent aims to work as an in-between of interpersonal communication. Our agent is designed to conduct simple question and answer so that people whose conversation is faltering can find a common topic to talk about. Another possible solution for such an awkward situation is providing an information search tool to find a common topic based on the retrieved data about the social identities of conversation partners. However, that tool does not help the process to start a conversation. There is a gap between finding topics and beginning conversations. Through question and answer, people can share one another's answer to the same question. That is an opportunity to start a conversation based on the answers. Furthermore, it may be invasive for the participants' privacy to collect personal information about conversation partners.

We conducted two experiments to analyze the influence of our social agent on interpersonal communication. In the first experiment, the agent supported cross-cultural communication between American and Japanese students. We observed how the agent's assistance influences the impression of the conversation and its partner. In this experiment, we found the agent can play a great role in human communities. Establishing relations with others is a basic aspect of sociality, and so we thought the agent might control human relations in the community. In the second experiment, the agent tried to control human relations. We observed how the agent's attitude influences human relations. The results of both experiments revealed the potential ability of social agents.

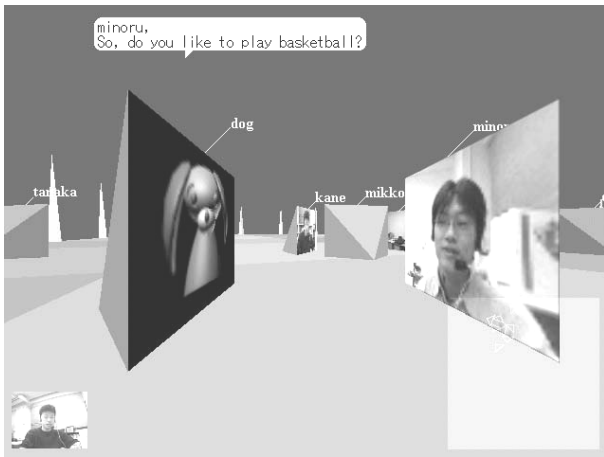


Fig. 1. Social agent in a virtual space

2. Design of the Social Agent

Our social agent acts in the virtual space called FreeWalk. FreeWalk provides a three-dimensional space where people can meet and move freely (see Fig. 1). In this space, a pyramid of three-dimensional polygons represents each participant. The system maps live video of each participant on one rectangular plane of the pyramid, and the participant's viewpoint lies at the center of this rectangle. The view of the space from a participant's particular viewpoint appears in the FreeWalk screen. Since distance attenuates voice, a participant must approach the others in

order to talk to them.

In FreeWalk, our agent basically acts in the same way of a busy party host looking for clues that the guests' conversations are going badly. The agent tracks audio from a two-person conversation, to look for longer silences that will trigger its conversation aid. When the agent finds the pause, it approaches to the conversation pair. The agent then directs a series of yes/no questions to both conversation partners in turn, and uses their answers to guide its suggestion for a new topic to talk about. Then the agent retreats until it is needed again.

The agent is embodied the same way of users. This allowed us to take advantage of nonverbal cues in designing the agent, such as a spatial position and direction for turning to face users. The agent decides how to position itself, based on the location and orientation of each participant. The agent tries to pick a place where it can be seen well by both people, but also tries to avoid blocking the view between them. The agent orients its face toward the conversation partner it is addressing so that the pair can intuitively recognize whom the agent asks.

2.1 Interaction design

The agent presents questions to the participants in a text-balloon above its head. We did not use synthesized voice because we were afraid that unnatural utterance may affect participants, and participants may fail to catch what the agent says. The participant indicates 'yes' or 'no' by clicking the mouse on his/her answer displayed under the question in the text-balloon. We did not use natural

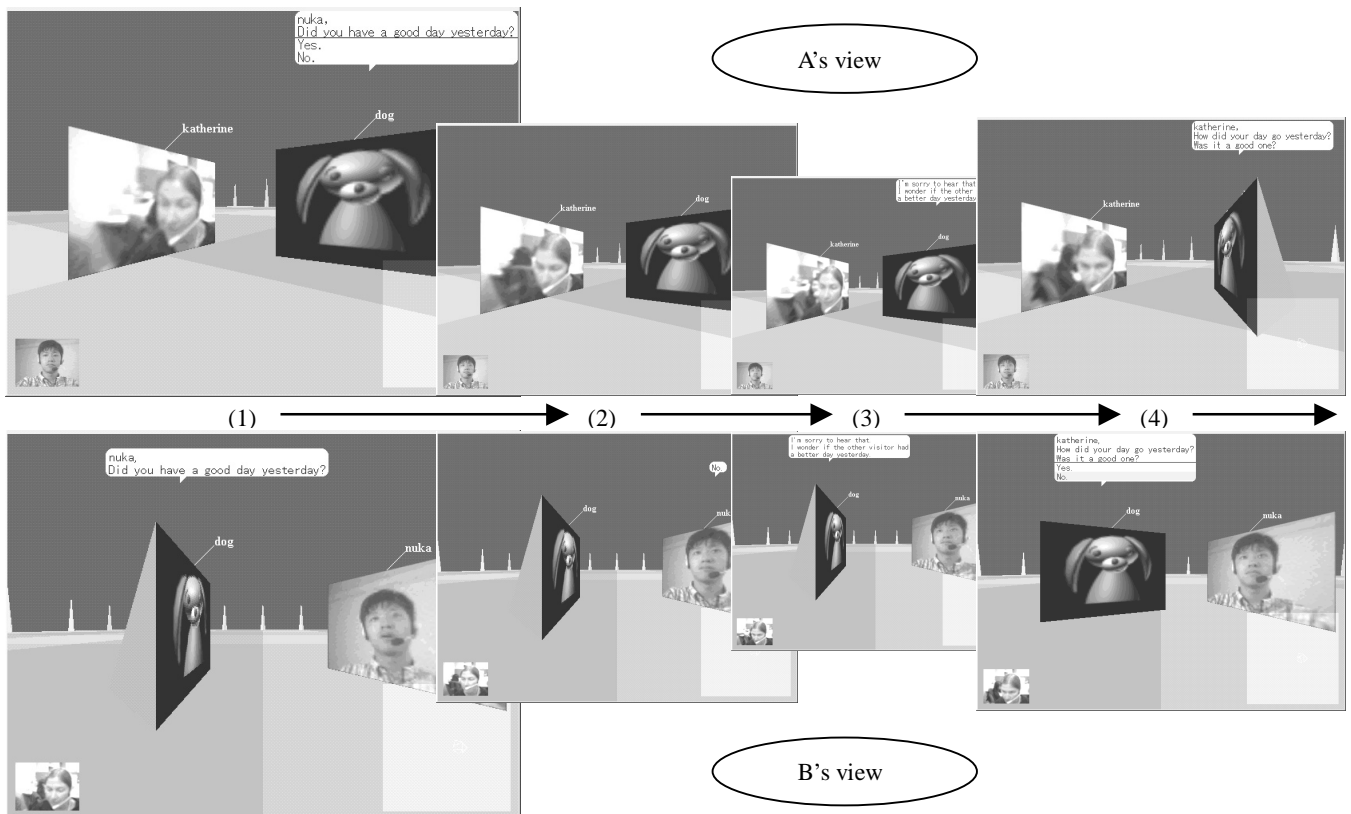


Fig. 2. Conversation from both participants' viewpoints: (1) person A is asked the first question (2) and responds, (3) then the agent comments. (4) Next person B is asked a question.

language as an input interface to prevent participants from expecting too much intelligence of the agent, since they might be frustrated by not smooth conversation with the agent. Both participants see all questions, but only the addressed person sees the Yes/No options. When the person answers the question, his/her answer is displayed in a text-balloon above his/her own embodiment (see Fig. 2).

Each topic has a tree structure, with nodes that are: a question for a participant, possible answers by participants, agent's reply to each answer, and flags indicating whether the agent will address its next question to the other person or to the same person. Topics were designed to draw participants into a dialogue, so each turn is tailored for this purpose. Basically, the agent asks both participants the same question to draw shared or conflicted points from the interaction. The cycle always concludes with a recommendation for how the participants could make use of the particular topic area, given their own answers to the agent.

When the agent approaches to start a cycle, it selects a topic from its repertoire of topics randomly, out of those that have not yet been used. Then it randomly chooses one of the two participants as the target for the first question. Let's call this person A. When A answers, the agent replies to A's answer. Based on what A answered, the agent then chooses a follow-up question. This question might be directed at A or at B. If it is directed at B, the agent turns to B to pose the question. When B answers, the agent makes a general comment that is meant to guide the participants into using this topic. This general comment is selected based upon the previous answers from the participants. Figure 2 shows a part of this cycle from both participants' point-of-view. In this figure, (1) person A is asked the first question (2) and responds, (3) then the agent comments. (4) Next person B is asked a question. As we described above, the agent faces the person it is addressing.

3. Influences on Cross-cultural Communication

This experiment was collaboration among NTT, Kyoto University and Stanford University. We used a dedicated line provided by NTT to connect both PCs in the two universities.

For testing our agent, we focused on an extreme case of low social context in a virtual meeting space: strangers from different national cultures, meeting for the first time. Even when people can use a common language with reasonable fluency, they do not necessarily have a common context for their conversation. Different cultures have different notions of how to begin and develop conversations. What is a safe topic that is unlikely to harm the conversation and destroy the relationship in one culture, may be very unsafe in another culture. For example, in some cultures it is appropriate to ask about family members right away; whereas in other cultures this is private ⁹⁾. Since it is very hard to establish a common ground in this sort of meetings,

we thought we could find the clear effect of our agent's assistance in conversations. We focused on conversations between Japanese and Americans. These two national groups are known to have very different interaction styles and cultural norms ⁹⁾, and so we felt this was a good test case.

We gathered safe and unsafe topics for the first time meeting, using a Web survey, which university students from Japan and the United States filled out. We used the collected pool of topics to select common safe and unsafe topics for people from both countries. From these topics, we crafted a set of questions that the agent could ask in the question and answer process. Safe topics included: movies, music, the weather, sports, and what you did yesterday. Unsafe topics included: money, politics, and religion.

3.1 Design of the experiment

Our initial expectation is that the safe-topic agent would create a more satisfying experience, than if there were no agent. Participants would feel they were more similar, would be happier with the interaction and conversation partner, and would form more positive impressions of one another's nationality. We designed a three-condition experiment using pairs of students who were located in the United States and in Japan. Pairs either interacted one-on-one, or had the help of the safe-topic or unsafe-topic agent. We divided the twenty-minutes conversation session into five segments, and forced the agent to display a topic within each four-minutes segment. The agent looked for an awkward pause during a minute in each time segment. The agent introduced topics immediately if it could not find a pause. Thus, in the safe-agent condition, the agent introduced all five safe topics in random order. In the unsafe-agent condition, the agent introduced all five unsafe topics in random order.

The Stanford students were a part of an undergraduate class, which required participation in experiments for credit. The Japanese students were undergraduates from Kyoto University and other nearby universities, who were paid for their participation. In total we had ninety participating students. Students were assigned randomly to same-gender pairs. Each pair was randomly assigned to one of the three conditions. Students were told that they would be testing out a new communication environment with a student from the other country. They were asked to talk about anything they liked. They were trained in how to use the system, and then left alone to talk for twenty minutes. After their conversation, participants filled out a survey. The questionnaire included questions about the conversation, their conversation partner, and the agent (in agent conditions). We also asked them to make assessments of themselves, and the typical person of both participants' cultures on some commonly used stereotypic adjectives.

3.2 Results

The statistical analysis result of questionnaire data shows our agent strongly influenced subjects' impressions of the agent, their partners, and stereotypes about their partner's

nationality.

In the experiment, the safe agent had positive effects for American students. Their opinions of their own behavior, their partner, and the typical Japanese person were higher. On the other hand, it had negative effects for Japanese students. Their opinions of the experience, their own behavior, and the typical American person were lower. But simultaneously it made them think their partner was more similar to themselves. One reason of these different effects may be that the agent's questions were implemented in English. It's possible that Japanese subjects felt it was a two-against-one situation. Another reason may be that Japanese subjects disliked the sudden interruptions by the agent that failed to find an awkward pause. Most of Japanese subjects seemed to be interested in talking with Americans.

In the unsafe agent condition, both Japanese and American students thought their conversations were more interesting, and Japanese students acted more American. This result indicates that it may be possible to mold user behavior with the choices one makes about how the agent behaves and what it talks. Safe/unsafe agents were perceived differently by Japanese and Americans. Americans preferred the safe agent while Japanese preferred the unsafe agent.

4. Influences on Human Relations

In the second experiment, we observed how our social agent influences human relations. We used the balance theory as a tool to evaluate the agent's influence on human relations. The balance theory states that two people's relations depend on whether both persons have the same sentiment toward a certain object¹⁰⁾. If this theory can be successfully applied to the relationships between the agent and two people, we can see the agent's influence on the relationship between two people. To confirm this idea, we investigated whether our agent can play the role of such an object based on this theory. We tested the capability of the agent to win a favorable feeling from both people or from only one side while the other side develops an unfavorable feeling towards the agent. And we tried to observe people's relations change according to the balance theory.

4.1 Balance theory

Since the balance theory can explain interaction in human relations¹¹⁾, we verified that similar interaction could occur between a human-agent relation and human relations. The balance theory can be applied to the relations between two people and an object X, which can be a person, a thing, or a fact^{12),13)}. When you have a positive or negative sentiment toward X and think that your partner has the same sentiment toward X, you have a positive sentiment toward your partner. If you think that your partner has a different sentiment toward X, you have a negative sentiment toward your partner. If X is a person, this theory explains the human relations among three people. In our experiment, X

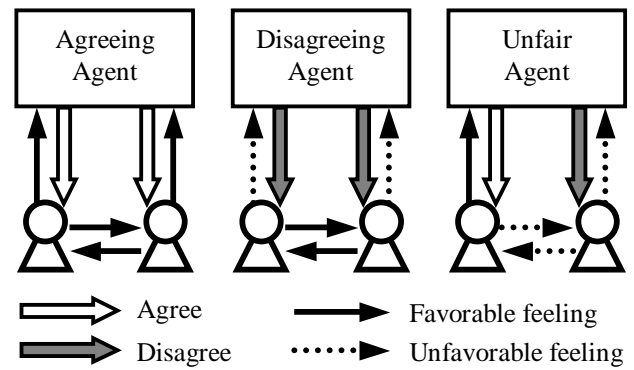


Fig. 3. Balance theory with agent and two humans

is an agent. We observed a situation in which the agent tries to control the sentiment of the relation between two subjects by controlling each subject's sentiment toward the agent. Actually, X can be a thing or a fact, but we found that a fact only has enough influence to cause agreement or disagreement when it involves a controversial issue or a strong like/dislike in food, and that in any case it cannot change the direction of agreement/disagreement. However, the agent itself differs from an issue or food, since the agent autonomously establishes its relations with others by communicating in the same way people do. It is difficult to match two people's sentiments to things or facts by controlling one's sentiment, but this may be possible when an agent is used as an object in this way.

We made the agent express an agreeing or disagreeing attitude to observe how subjects develop favorable/unfavorable feelings toward the agent. This would be verified if a subject had more positive sentiment toward the agent when its attitude is agreement than when its attitude is disagreement. We assume that subjects think their partners would respond to the agent similarly. On the assumption that the agent can control its impression, we tried to determine whether the balance theory works in the following three conditions. The first condition is that the agreeing agent agrees to both subjects' opinions. The second is that the disagreeing agent disagrees with both of their opinions. The third is that the unfair agent agrees to one subject's opinion but disagrees with the other subject's opinion at once. Figure 3 shows the three situations where the balance theory is valid. The theory is valid if a subject comes to have more positive sentiment toward his/her partner when the agreeing/disagreeing agent shows an agreeing/disagreeing attitude to both subjects than when the unfair agent shows a different attitude for each subject.

The agent's influence may be weakened when human communication channels widen. We tried to confirm that the agent's influence is weaker when the two subjects have a conversation than when they do not. Additionally, we compared an environment where the content of the conversation between the agent and the partner is hidden with another environment where their conversation is known. We aim to determine whether the subjects' sentiments toward the agent influence their relations, however, we expect their relations may inversely influence their sentiments toward the agent if their communication

channel is wide.

4.2 Statistical experiment

In a first-time meeting of about fifteen to twenty minutes, one subject met another subject and our agent to interact in FreeWalk. In this meeting, the subject established relations with his/her partner as well as the agent. In the experiment, before beginning the meetings, subjects were only told that they would interact with another subject and the agent. Subjects interact with the agent in the same way as that in the first experiment. All subjects were university students. A total of 185 people (113 male and 72 female) participated in our experiment. After the meetings, subjects answered the questionnaire about the agent, the agent from the partner's point of view, and the partner in terms of similarity and attractiveness.

We compared four distinct environments formed by the effects of two factors, each of which has two levels. One factor is the steps of establishing agent-human and human relations, which are sequential or simultaneous. In the sequential environments, subjects develop their sentiments toward the agent before they develop their sentiment toward their partner by learning their partner's sentiments toward the agent. In the simultaneous environments, these steps are done concurrently. The other factor is whether subjects can talk with their partners or not. We prepared conversational environments and non-conversational environments. We assumed that both of the two factors would widen or narrow the communication channel between the two subjects.

As the result of analyzing the questionnaire data, we found the agent could influence human relations under the situation in which people could not have a conversation, and the agent established relations with them before they established their relations while each subject could not know what the agent and the other subject was talking about. In the case that agent-human relations and human relations were established simultaneously, the agent's influence on human relations became a little weaker. Even in the case when the agent established relations with people beforehand, the agent lost his ability to influence their relations, if they were provided with a few chances to talk with one another during the establishment process. If the agent had to join the conversation of people to try to establish relations with them and to influence their relations, it was very hard for the agent to influence their sentiments toward it, which is the preliminary step in influencing their relations.

4.3 Follow-up analysis of conversation

Why do agents lose the power of influence for human relations when subjects talk to each other? In order to find the cause, conversation recorded in the simultaneous conversational environment was examined by conversation analysis¹⁴⁾. Within this environment, agent-human conversation is carried out through the text channel, and human-human conversation is carried out through the vocal-speech channel. But unlike the statistical experiment, a WOZ (Wizard of Oz) agent, which is controlled by the

experimenter secretly, is introduced to make its behaviors look more natural, by presenting topics and giving inductive talk before questions.

(Ex1) is a transcription of a part of the conversation. In the transcription, A and B are subjects, and X is the agent. 'A=>B' means A speaks to B. Italic sentences are talk through text channel. Some exchanges of subjects through the vocal-speech channel (=>2) are inserted between the two parts of the adjacent pair on the text channel, the question of agent (=>1) and the subject's answer (=>3). This phenomenon shows the relative usability of vocal-speech channel over text channel and talking to the partner has priority over answering the agent.

(Ex 1) Remarks about the agent-human exchange

=>1 X=>A: *Mr. A, this is very off the subject though, do you often listen to music?*
=>2 A=>B: That is very off the subject, don't you think? (laugh)
=>2 B=>A: I think so, too. Who would have expected a dog to have consideration? (laugh) It seems that he is paying attention to the flow of conversation.
=>2 A=>B: He is clever, in a sense. (laugh)
A=>B: ...Well, often.
=>3 A=>X: *Yes*
X=>A: *I see.*

As for its contents, in addition, conversation between subjects often includes mention or remarks on agent-human exchange. The vocal-speech channel between subjects is used as another communication channel that is placed at the meta-level in agent-human exchange. Through this channel, subjects often evaluate the behaviors of the agent and reach an agreement. The underlying assumption made here by both subjects is that the agent cannot understand their conversation through this channel. Therefore, could the influence of the agent be sustained by limiting the occurrence of this parallel channel? To examine this point, an experiment using text chat was carried out. As a result, occurrences of a parallel channel decrease drastically. However, the result of questionnaire was not so much different from the one in the simultaneous conversational environment of FreeWalk. There are many unsolved problems that cannot be resolved even by restraining the parallel channel. As a serious problem, disagreement expressed by the agent (=>1) causes the antipathy of the subjects toward it (=>2) and leads to sympathy between them in (Ex 2).

(Ex 2) Sympathy between subjects

=>1 X: *I do not hit it off well with Mr. A, because you want to visit Universal Studio Japan.*
A: *...Fine.*
=>2 B: *Well, I think Mr. X is kind of rude.*
A: *I'm afraid I'll never get along with him.*

One of the reasons why such sympathy is caused is the form of disagreement utterance of the agent. In general, while agreement can be expressed directly and immediately,

disagreement utterances are accompanied by many devices, such as hesitation, indirect and mitigated expression, giving a reason for the disagreement, and so on ¹⁴). In this regard, the disagreement utterance of the agent, which lacks these devices, sounds unnaturally strong and therefore rude. Another reason is subjects' consideration of the 'face' of participants. People in public places generally take care to "save face," and they also take similar measures for the 'face' of others ¹⁵). For example, when someone stumbles over a stone on the road, people around him tend to pretend not to notice it. Similarly, in (Ex2), subject B willingly tries to recover the partner's face after it is threatened by explicit disagreement of the agent in the public conversation ($\Rightarrow 2$), and this motivates the subjects to have sympathy for each other. The agent's infelicitous behaviors caused by its inability to engage in natural conversation can lead to the antipathy of the subjects toward the agent and sympathy with each other. As a result, this reduces the effect on human relations that the agent has aimed for.

5. Conclusion

In the first experiment, it is found that the agent's behavior strongly influenced people's impressions of the agent, their conversation partners, and even stereotypes about their partner's nationality. In the second experiment, it is found that the agent's attitude influenced subjects' sentiment toward the agent and their relations.

These results suggest that social agents are more than conversational agents. When we design conversational agents, we can focus on human-agent interaction. To design agents entering into human communities, we have to consider those agents' effects on interpersonal matters, which are communication, relationship, and so on. We hope our studies are helpful in designing useful and safe social agents.

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