The Effect of Virtual Agent Warmth on Human-Agent Negotiation

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ABSTRACT

The perception of warmth and competence in others influences social interaction and decision making. Virtual agents have been used in many domains including serious gaming and training. In this work we study the effect of warmth expressed in the behavior of a virtual agent on a human-agent negotiation. We design and conduct an experiment where participants negotiate with two versions of the same agent displaying varying levels of warmth. The results show that humans are more satisfied with the warm agent, are more willing to renegotiate with it, would recommend the agent more to their friends and had a better interaction experience, even though there is no difference in negotiation outcome (utility, agreement or rounds needed). While studies have shown effects of emotional displays on negotiation and collaboration, this is - to our knowledge - the first time that a clear effect of behavioral style is shown on the post-hoc appraisal of a human-agent collaboration, in our case a negotiation.

KEYWORDS

Negotiation; Virtual Agents; Warmth; Agent Modelling

1 INTRODUCTION

Over the past couple of decades, negotiation has drawn a lot of attention from the behavioural science and Artificial Intelligence communities. The negotiation domain has been argued to be a model system for human-agent interaction studies [16]. Efforts have been made to document effects of virtual agents' social behaviour on, for example, the negotiation outcome or the perception of fairness when negotiating with humans. Most of the studies that look at social behaviour, however, focus on emotion modelling and emotional displays [5, 8, 9]. Little research has touched upon

the effect of the agent's social style on humans in human-agent negotiations. Typically, social style is modelled by two dimensions: warmth and competence [6, 14]. Warmth defines the friendliness or trustworthiness of the other, whereas competence describes the perceived level of ability. Various effects of warmth and competence during human-human negotiations have been reported. Johnson [20], for example, reported that the willingness to compromise when negotiating increases with the warmth of the person. Demoulin and Teixeira [11] reported that when one negotiates with a person associated with high competence, the perceived target point of that person is higher.

In this work, we are interested in the effect of warmth of the agent on human-agent negotiations. Specifically, we study the effect of agent warmth on the negotiation outcome and the perception of the negotiation.

The remaining part of this paper is structured as follows: Section 2 discusses relevant previous works in the field of negotiation agents and behavioural sciences. In Section 3, we formulate our research questions and present our hypotheses for the same. Section 4 describes our experimental setup, required tools and evaluation metrics. In Section 5, we report our analysis and results. Section 6 summarizes our study and discusses possible improvements and directions for future work.

2 RELATED WORK

Emotions can affect the negotiation process in different negotiation phases [5]. The effect of emotion in negotiation between humans and agents has been studied intensively. For instance, De Melo et al. examined the effects of anger and happiness [8] and sadness and guilt [9] on human-agent negotiation, which showed an impact on the negotiation process and outcome.

Furthermore, virtual negotiation agents can aid negotiators during complex negotiations, or can be used for training and preparation [4, 10, 15]. Ding et al. [12] considered virtual reality when building a negotiation training system that aims to improve people's self-efficacy and negotiation knowledge.

To the best of our knowledge, no research has been conducted on the link between virtual agents' behavioral style and the negotiation outcomes. Johnson [19] studied the effect of warmth and anger on the actor (the one expressing it) and listener during a negotiation. Furthermore, Druckman and Olekalns [13] showed

that warm managers, unlike indifferent ones, facilitated the development of a cooperative relationship and helped employees address issues in a comprehensive fashion. Moreover, Barsade [1] studied emotional contagion in groups dynamics and showed favorability when dealing with positive emotions. Additionally, if one side of a discussion perceived that the other side gave him or her sufficient chance to speak, he or she tended to treat them better and were more likely to reach a fair outcome [29]. Perception of warmth seems to have a strong influence on the negotiation, however, it is still unclear whether this holds for human-agent negotiation.

Several attempts have been made to model warmth in virtual agents and robots, mostly focusing on non-verbal behavior rather than speech. Nguyen et al. [22] used real-life observations of gestures, repeated patterns, facial expressions, postures and space usage to model warmth and competence in a virtual character. They also observed that clothing and appearance influenced the perception of warmth and competence. In addition, for a virtual agent that was used as a software assistant, warmth and competence correlated with the pereived believability of the agent [26]. Bergmann et al. [2] modeled human-like and robot-like virtual agents and embedded warmth and competence through non-verbal behavior and appearance. Humans judged warmth quickly, mostly in less than a minute. Moreover, once the first impression regarding warmth was formed, it was hard to change it in subsequent interactions. Finally, even subtle variation of the expression of warmth and competence can be measured when tested on children in a human-robot interaction setting [24].

Perceived fairness and outcome satisfaction are important factors when one considers emotions and social perceptions in negotiations. Thompson et al. [27] stated that negotiators felt less successful when their opponent was happy rather than disappointed during a negotiation, and negotiators that felt successful stated that they felt less honest, sincere and fair. In their study on fairness and emotions, Hegtvedt and Killian [18] indicated that the perceived fairness of a deal could lead an individual to feel more pleased about the negotiation process, but whether or not the negotiator was comfortable with his or her performance in negotiation can be an especially important outcome for many negotiators [7]. Also, Oliver et al. [23] conducted a study of perceived post-settlement satisfaction using expectancy dis-confirmation, which used various factors such as willingness to renegotiate and raised expectations. They indicated that high expectations lead to less satisfaction, which was not the case in the high-profit outcome.

3 RESEARCH QUESTION

Here we study the influence of warmth expressed in the behavior of a virtual agent on human-agent negotiation. There are multiple ways in which the warmth of the agent can potentially influence the negotiation session. Firstly, we look at the influence on the objective measures pertaining to the negotiation outcomes, such as utilities. Secondly, we look at the human's subjective perception, such as fairness of, and satisfaction with the outcome, and willingness to renegotiate.

3.1 Hypotheses

Based on related literature, we expect that the warmth of the negotiation agent influences the negotiation session. Johnson [20] found that people see their own position as more favorable when the opponent is warm, even though in his study he did not find an influence of warmth on reaching an agreement. Based on this, we hypothesize that the agent obtains a less favorable outcome when displaying warm behavior as opposed to cold behavior.

Welsh [29] states that the human perception of the fairness of the negotiation outcome is influenced by the way they feel they were treated. The subjects that felt that they were treated with respect were more likely to perceive the outcome as fair. Hegtvedt and Killian [18] noted that if individuals perceive the bargaining process as fair they are more likely to feel pleased about the way the negotiation went. Oliver et al. [23] showed that satisfaction is the driving factor for willingness to renegotiate. Finally Johnson [20] found that warmth promotes interpersonal attitude. Thus, we hypothesize that the Willingness to renegotiate, the perception of fairness of, and the satisfaction with the negotiation outcome increase with the warmth of the virtual agent.

4 METHOD

We took an experiment-based approach to study our hypotheses. We developed two version of the same agent of which the behavior and appearance differed on the warmth dimension. Based on related literature discussed above, we used multiple modalities including gestures, dialogues and appearance to build the two versions, which are discussed in detail below. Subsequently we performed a pilot study to validate the perceived difference in warmth. Lastly, we collected data pertaining to the measures discussed in Section 4.3 and analyzed them.

4.1 Materials

For the task of building agents with different warmth levels, we used the Virtual Human Toolkit [17]. Various components of the toolkit can be modified to model varying warmth levels in virtual agents. The components that were modified are the gestures, the expression, the gaze and the appearance of the agent. Additionally, dialogues were modified slightly to further enhance the variation of warmth. Images of the two versions of the agent can be seen in figure 1.

The first parameter that was modified is the expression. Nguyen et al. [22] state that a happy face is related to a warm person while a cold person has a neutral or even slightly irritated face. Another parameter that was modified are the gestures. According to Nguyen et al. [22], a warm person has more open gestures, while a cold person has closed gestures. These findings were translated to the virtual agents by making the warm agent smile slightly and make open gestures to support his dialogue. The cold agent on the other hand has a neutral expression and keeps his hands close to his body not gesturing much.

Nguyen et al. [22] also found that the way someone gazes is a sign of warmth. People with high warmth have their eyes fixated at the audience, while people with low warmth tend to divert their gaze frequently. To model this, the warm agent was programmed to always look at the camera. The cold agent, on the other hand,

Figure 1: The agent plays the role of a mobile stores salesman. The cold version is on the left, the warm version is on the right.

was programmed to frequently change his direction of gaze during the conversation.

The change in appearance was restricted to the color of the clothing. Mehta and Zhu [21] found that blue is associated with being calm and approachable. Singh and Srivastava [25] state that blue is associated with trust and tranquility whereas dull colors like grey are associated with reserved. Thus, the warm agent was dressed in a shade of blue while the cold was dressed in rather dull colors.

Welsh [29] stated that people feel that they are treated more fairly when they are treated with respect and are given sufficient opportunity to speak. This was translated to the agents by writing different dialogues for both scenarios. The warm agent asks the person questions and gives a lot of opportunity for the person to respond and share his/her preferences. On the other hand, the cold agent does most of the talking and only gives the person room to respond when it is necessary for the scenario.

Our negotiation system was inspired by van Kleef et al. [28]. We used a 1-on-1 "fixed pie" negotiation scenario, i.e. one person's loss is the other's gain. The agent played the role of a mobile phone store salesman and the participants played the role of a customer. The participants were required to negotiate with the agent on the price, warranty period and service contract of a mobile phone. Each of the three issues have 7 levels and associated points as illustrated in the Table 1. Each bid or offer is a triplet of issue levels $\{L_P, L_W, L_S\}$, with L_P being the price level, L_W the warranty level and L_S the service level. Total points (the non-normalized utility) of an offer for the participant is given by

$$U^{\text{participant}}_{\{L_P, L_W, L_S\}} = 50L_P + 15L_W + 30L_S - 95. \tag{1}$$

Table 1: Issue levels for defining a bid and associated points for the participants

Price		Warranty		Service	
Level	Points	Level	Points	Level	Points
1 ($250)	0	1 (1 month)	0	1 (1 month)	0
2 ($245)	50	2 (2 months)	15	2 (2 months)	30
3 ($240)	100	3 (3 months)	30	3 (3 months)	60
4 ($235)	150	4 (4 months)	45	4 (4 months)	90
5 ($230)	200	5 (5 months)	60	5 (5 months)	120
6 ($225)	250	6 (6 months)	75	6 (6 months)	150
7 ($220)	300	7 (7 months)	90	7 (7 months)	180

We ensured the negotiation was meaningful to the participant and involved both competition and cooperation in the following manner. Participants were instructed to maximize their points and we offered a total bonus of $50 to the participant(s) who achieved the maximum points. This favors competition in the negotiation. Also, the participants were told that the agent could stop the negotiation in any round which would result in 0 points. This favors cooperation in the participants.

Since we have a "fixed pie" negotiation setup, the agent's utility is complementary to the participant's utility and is given by:

$$U^{\text{agent}} = 570 - U^{\text{participant}} \tag{2}$$

4.2 Experimental setup / approach

For the main study we conducted a between-subject experiment where the participants were randomly divided into 2 different groups. Each group was assigned to one of the agents and each

participant of the group had a 1-on-1 experimental session of approximately 5 minutes with that agent.

Each session was divided into two phases. The first phase was the introduction of the environment (the phone store) where the participants had a short conversation with the agent. They were shown short videos in which the agent says something after which the participant were provided with a few options to respond to the agent. Participants would select the options through a web-based interface by the clicking the option. The content of the short conversation was a sales intro and some small-talk. This phase did not influence the second phase. The second phase of the scenario was the negotiation phase. During the negotiation, the participants were provided with a short video of the agent offering a bid. After the video, the participants had the option to accept the bid of the agent, or to make a counter offer. This was done again through a web-based point and click interface. This process repeated itself for 6 rounds in which the agent would bid according to a scripted sequence of offers. Both agent versions offered bids in the same scripted order: $\{2, 3, 2\}, \{2, 3, 3\}, \{2, 4, 3\}, \{3, 4, 3\}, \{3, 4, 4\}, \{4, 4, 4\}$. So, in both the warm and cold conditions the agent ignores what the user bid is. The negotiation would end in case of an agreement or after 6 rounds, whichever was earlier. Agreement was reached when a participant accepted or proposed a bid with a total utility that is less than or equal to 285 (sum of level 4 for all issues).

After the session, the participants were asked to fill in a questionnaire about their experiences and opinions pertaining to the subjective measures described in Section 4.3.

We created a web environment for the experiment to make it easily available to a large set of participants. For conducting the experiment, we used the crowd-sourcing platform Amazon Mechanical Turk. In total 252 participants participated, 126 participants in each condition, which was sufficient for a medium-sized effect study [3].

Before conducting our main study, we did a pilot study to verify that our agents were perceived as warm and cold. This study involved participants rating the perception of the two agent versions. 16 subjects (within subject design) participated in the pilot study (family, friends and fellow students of the researchers with an age range of 19 to 52 year, median=26). Each participant saw both agent conditions. None of the pilot participants participated in the main experiment. Participants were not instructed about the different styles. They were presented two web links (for the two versions) and asked to rate their perception of the agent (see below in measures section) as well as provide qualitative feedback (not reported upon in this study). For the rest the pilot was identical to the main experimental setup. We performed a one-shot validation (no design iterations were performed).

4.3 Measures

4.3.1 Pilot study. : For the pilot study, we obtained 9-point Likert scale ratings on Friendliness, Sincerity, Trustworthiness, Tolerance and Nature of the agents. As discussed by Fiske et al. [14], these are indicators of warmth. We also asked participants to rate perceived warmth of the two versions of the agent on a 9-point Likert scale. These ratings were used for analysis and validation of our agent design.

4.3.2 Negotiation experiment. : To test our hypotheses, we identified two kinds of data measures - measures pertaining to utility and measures pertaining to the participant's perception of the negotiation session. Since acceptance criteria, value of an offer, and the sequence of the offers are exactly the same for both agents, the differences in these measures can be attributed to the difference in warmth of the agents. Measures pertaining to utility included:

(1) Agreement percentage: This is the percentage of participants who either accepted the agent's offer or offered a bid which was acceptable for the agent. This measure indicates the ability of the agent to reach an agreement.
(2) Utility of the agent: The utility of the agent is the utility of the bid agreed upon (calculated by equation 2). In case of no agreement, this measure is taken to be 0. This measure is calculated for each participant that the agent negotiates with.
(3) Best utility offered to the agent: This measure is computed from the bids offered by the participants. We define this measure as the bid with the best utility for the agent among the bids offered by a participant,

$$U_{\text{Best}} = \max \left\{ U_{\text{bid}_1}^{\text{agent}}, \ldots, U_{\text{bid}_6}^{\text{agent}} \right\}. \tag{3}$$

This measure is also calculated per participant and takes into account non-agreement cases as well. This measure shows the extent to which a participant concedes.
(4) Number of rounds: This measure is computed per participant and is defined as the number of bids offered by the participant before the negotiation ended. This measure signifies how fast or slow the participant is conceding.

To evaluate the participant's perception of the negotiation, we collected 9-point Likert ratings for the following measures:

(1) Satisfaction with the outcome of negotiation: This measure shows how good or bad the participants think the deal is. Since the negotiation strategy of the agent and the best possible outcome are unknown to the participants, this measure depends solely on the subjective perception of the participants.
(2) Perceived fairness of the outcome: This measure shows to what extent the participants believe the agent is negotiating reasonably and not trying to gain unfair advantage.
(3) Willingness to renegotiate: This measure is calculated as an average rating of 2 popular business survey questions - "How likely are you to do business with the agent in future?" and "How likely are you to recommend the agent to your friends or relatives?"

5 RESULTS AND DISCUSSION

5.1 Pilot study

We studied the distribution of the perceived warmth of he two agent versions as plotted in Figure 2. The warm agent has mean = 7.06 and SD = 0.85 whereas the cold agent has mean = 5.25 and SD = 1.53 and this difference was statistically significant as shown by a repeated measures ANOVA $F(1, 15) = 35.1$ with $p < 0.001$. Moreover, ratings of the warmth indicators were also different at significant levels, except for trustworthiness (see table 2). The

Table 2: Effect of style on agent perception in pilot study

Measure	μ_{warm}	μ_{cold}	p-value	
Friendliness	7.813	6.438	0.000	**
Sincerity	7.438	6.313	0.002	**
Trustworthiness	6.750	6.625	0.718	(ns)
Tolerance	7.188	5.813	0.006	**
Nature	7.438	6.188	0.004	**
Warmth	7.063	5.250	0.000	**

* indicates $p-$value < 0.05 and ** indicates $p-$value < 0.01

multivariate model was significant as well (F(6,10)=7.515, p=0.003). This implies the warm agent is perceived warmer than the cold agent and hence validates our design. It further shows that all but trustworthiness are good indicators for the perception of warmth in agents.

5.2 Negotiation experiment

The first measure we looked at was the percentage of agreements for both the agents. There was no significant difference between the warm agent, 95 agreements, versus the cold agent, 86 agreements, out of 126 participants for each agent (X2(1)=1.588, p=0.208, ns).

We performed individual ANOVA's to determine the statistical significance of the effect of the cold versus warm agent on the other outcome measures (Table 3). We also verified the homogeneity of variance of our data through Levene's test.

We found a $\alpha = 0.1$ significant effect of warmth on best utility offered to the agent at $(F(1, 250) = 2.902, p = 0.09)$, but not on the utility of the agent $(F(1, 250) = 1.747, p = 0.188)$. The effect of agent style on utility became even less when we analyzed it for only the participants who reached an agreement $(F(1, 181) = 0.159, p = 0.690)$. Further, no significant effects were found on the number of rounds needed to close the negotiation, or the perceived fairness of the agent (see Table 3). This indicates that there was no effect of agent style on negotiation outcome or bidding.

The negotiation with the warm agent is perceived as more satisfactory $(F(1, 250) = 5.845, p = 0.016)$. Similarly, the willingness to renegotiate with the warm agent is higher $(F(1, 250) = 5.171, p = 0.024)$. Interaction experience and whether participants would recommend this salesperson (agent) to their friends was influenced by warmth of the agent: interaction experience was higher for the warm agent $(F(1, 250) = 5.507, p = 0.020)$, and participants indicated they would recommend the warm agent more to their friends $(F(1, 250) = 5.102, p = 0.025)$. This indicates that there was a significant effect of agent style on the perception of the negotiation.

5.3 Discussion

Our results show that expression of warmth by a virtual agent can affect human judgment of the negotiation, even when the effect on the negotiation outcome is limited. This is interesting as it shows that social style really does matter on its own, without mediation of the negotiation outcome. De Melo et al. [9] found that people are more willing to renegotiate with an agent who is showing joy than
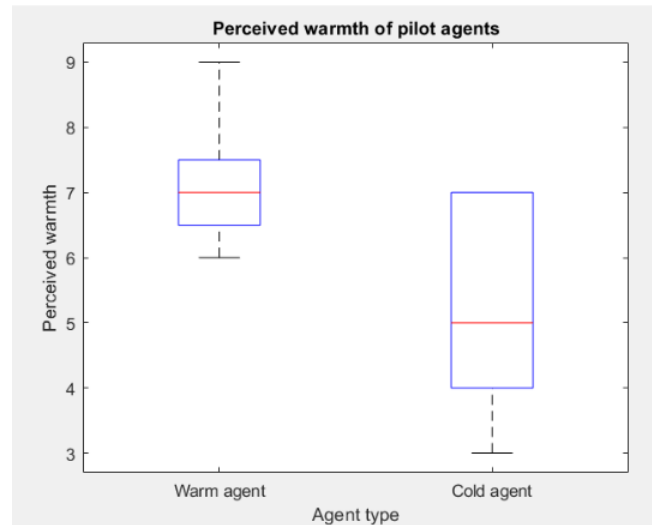
Figure 2: Box-plot of the perceived warmth of the two agents

Table 3: Results of hypothesis testing on various measures

Measure	μ_{warm}	μ_{cold}	p-value	
Utility of agent	265.4	237.9	0.188	
Best utility offered to agent	308.2	288.6	0.09	*
Number of rounds	3.119	3.27	0.541	
Satisfaction	5.523	4.77	0.016	**
Fairness	5.484	5.095	0.144	
Willingness to renegotiate	5.579	4.813	0.024	**
Interaction experience	6.151	6.913	0.020	**
Recommendation to friends	4.706	5.492	0.025	**

* indicates $p-$value < 0.1 and ** indicates $p-$value < 0.05

a neutral agent. We have used subtle expression of positive affect and there was no explicit reaction of joy in our agents. Oliver et al. [23] showed that people who are more satisfied with the negotiation outcome are more likely to be willing to negotiate again. Both of these works support our finding that people are more satisfied *and* are more willing to renegotiate with the warm agent. We found a strong positive correlation $(r(252) = 0.742, p < 0.001)$ between the perceived level of fairness and the level of satisfaction after negotiating with the agent. This confirms previous findings by others [18]. As identified by Welsh [29], the opportunity to speak during negotiation positively influences the perceived level of fairness of a negotiation. The dialog of the warm agent involved questions to the participants during the introduction phase while that of the cold one did not, even though there was no difference during the negotiation phase. We propose that this perception of fairness is induced by the style of the agent.

Another interesting result is that we did not find an effect of agent style on the final utility obtained, agreements reached, or number of rounds needed to close the negotiation. This indicates that people are not influenced, in the end, by whether the agent is warm or cold

when it comes to their bidding behaviour. This is in line with findings by Johnson [20], who concluded that participants subjected to warm behavior felt a more positive attitude towards the opponent, but that a warm opponent did not influence the negotiator to reach an agreement. Apparently also in our study the MTurkers are outcome oriented in the negotiation as they do these tasks for monetary reasons. Even though they felt better in the warm agent condition about the negotiation and the agent afterwards, during the negotiation they resorted to getting a high utility for themselves as this was the criteria to win $50. This is an interesting finding for the validity of using MTurkers in such negotiation settings.

6 CONCLUSION

In this paper, we explored the effect of warmth in the behavioural style of a virtual agent during negotiations in a human-agent setup. We studied how the outcome of a negotiation, perceived fairness, outcome satisfaction and willingness to renegotiate is impacted by the warmth of a virtual agent. We modeled two versions of the same agent with different warmth, and validated warmth perception in a pilot study. Then, a crowd-sourced experiment was conducted to study the effect of these two versions on previously mentioned negotiation measures. Overall, the results show that humans are more satisfied with the warm agent, are more willing to renegotiate with it, would recommend the agent more to their friends and had a better interaction experience, even though there is no difference in negotiation outcome (utility, agreement or rounds needed). This is an important finding as it shows that social style expressed by virtual agents can alter the post-hoc appraisal of the negotiation, even though the outcome is similar. This directly replicates findings from social psychology [20], is important for training-purposes, and for social acceptance of such agents.

ACKNOWLEDGMENTS

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