



You Look Nice, but I Am Here to Negotiate: The Influence of Robot Appearance on Negotiation Dynamics

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ABSTRACT

This report presents two experimental studies examining whether relatively subtle differences in the appearances of humanoid robots impact (1) the outcomes of human-robot negotiation (i.e., utility scores) and (2) the participant's attitudes toward their robot negotiation partner. Study I compared Nao and Pepper, and Study II compared Nao and QT in identical negotiation settings. While the appearance of robots influenced the participant's attitudes toward the robot before and after the negotiation, such differences were not manifested in the utility scores. The consistent utility scores across different robots reassure that minor variations in the visual characteristics of robots do not alter how users negotiate with a robot. Yet, as participants felt differently about the three robots, there remains the possibility that the differences in their appearances may influence the user's initial inclination to approach each robot. As among the first to systematically investigate the influence of robot appearance on human-robot negotiations, this study emphasizes the importance of assessing both objective outcome scores and the subjective experience of the user in human-robot interaction (HRI) research and offers valuable insights for designing and implementing social robots in real-world settings including customer service and other AI-based interactions.

CCS CONCEPTS

• **Computing methodologies** → *Intelligent agents*.

KEYWORDS

Appearance, Human-Robot Negotiation, Humanoid Robots

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1 INTRODUCTION

The increasing prevalence of social robots across various sectors, such as education and workplaces [13], emphasizes the need for effective human-robot negotiation, from everyday encounters with customer service chatbots [20] to more complex scenarios involving group dynamics [10] and self-evaluation [29]. Recent years have observed research on the development of intelligent agents in joint decision-making, with studies exploring negotiation strategies [17, 19, 23, 33] and the influence of nonverbal behaviors [2, 7, 12, 31] as well as physical embodiment [6]. This paper investigates a yet under-explored aspect of human-robot negotiation — the physical appearance of the robot negotiator. Research suggests that physical embodiment is crucial in social interactions [16, 18]. Yet, most human-agent negotiations have been evaluated in chat-based or virtual environments [22, 28] except for a few demonstrating differing outcomes based on embodiment and facial expressions [6, 7]. To our knowledge, no study thus far examined whether differences in the appearances of robot negotiators positively impact how a human negotiates with a robot. We, therefore, conducted experiments where participants negotiated with different humanoid robots using a standard protocol [1], with the robots employing consistent negotiation strategies. Social robots come in vastly diverse appearances, but we decided to compare three commercial humanoids: Nao, Pepper, and QT. Although these humanoids are relatively similar, varied responses to these robots have been reported in domains other than negotiation [30]. In this research, we focused on subtle appearance differences between the three humanoid robots investigating if the responses will vary in the negotiation context although the robots are relatively similar. Across two studies, we empirically investigated the following research questions:

- (1) Does the appearance of a robot negotiation partner affect the negotiation outcomes?
- (2) Does the appearance affect the attitudes toward the robot?
- (3) Which features of the robots affect the outcomes/attitudes?

2 RELATED WORK

Robot appearances influence their perceived humanness, friendliness, and threat [14, 32]. For example, visual features such as facial characteristics and head size affect how human-like a robot

is perceived [8]. In contrast, lack of facial features leads to more machine-like impressions [14]. An extensive survey study based on 342 robots also reported that visual features, including surface textures and mechanical features predicted the robot's perceived competence and warmth [27]. In actual interactions, participants in a mock job interview with different robots perceived a highly human-like android as less trustworthy than a more machine-like robot [34]. Similarly, another study demonstrated that in the same interaction context, participants attributed more mental state to the Pepper robot than the NAO robot, highlighting the influence of their design differences on perceived characteristics [21]. These findings underscore the importance of investigating appearance in shaping how humans perceive while interacting with robots.

In the context of negotiation, several studies have explored different aspects of human-agent negotiation, though not robot appearances. Bevan and Fraser focused on the effect of handshaking in negotiation, showing that handshakes, especially with haptic feedback, increase cooperation [4]. De Melo *et al.* studied the impact of virtual agents' facial expressions on negotiation, finding that anger expressions led to more concessions from human negotiators [7]. Another research revealed that competitive strategies in negotiation cause humans to concede more [24]. At the same time, when agents expressed warmth, people were more willing to renegotiate even though negotiation outcomes were not affected [26]. In contrast, aggressive attitudes in virtual negotiations were found to affect emotions similarly to real-life interactions [5]. Finally, examining the impact of physical versus virtual embodiment in negotiation, Çakan *et al.* found that participants were more collaborative with a virtual robot compared to its physical counterpart [6]. These studies led us to speculate that the appearance of robots influences first impressions and post-negotiation attitudes, but the visual characteristics do not significantly affect the outcomes of negotiations. Yet, this remains the subject of empirical investigation.

3 PRESENT STUDY

3.1 Human-Robot Negotiation Mechanism

In our studies, the human participant negotiated with a humanoid robot using the Alternating Offers Protocol [1]. We chose a friendly negotiation context for planning a holiday trip and discussing certain issues: destination, accommodation, season, and event/duration. Prior to the negotiation, participants ranked these four issues according to their preferences. The preference ranking helps build up a utility function, which can assess the utility of the negotiation outcomes for the participants. Unknown to the participants, a conflicting utility function is also created for the robot. It is worth noting that each party knows only their preferences. Every participant negotiated twice, and the options for destination changed across the two sessions, but other issues remained the same. A disagreement results in zero utility for both parties. Here, utility signified the desirability of an offer, with the negotiating parties striving to maximize it. We calculated overall utility as the sum of weighted individual utilities. Table 1 presents the negotiation topics, options, and an example of prioritization and scoring.

Our robots autonomously create their offers using the "Solver" strategy from [15]. This strategy factors in the remaining time, the opponent's actions (i.e., how their offers affect the robot's utility),

Table 1: Weights of Issues and Values in Negotiation

Destination (0.48)	Accommodation (0.32)	Events/Duration (0.16)	Season (0.04)
Barcelona/Venice (1.0)	Hotel/House (1.0)	Shopping/1 Week (1.0)	Summer (1.0)
Rome/Lisbon (0.75)	Caravan/Hotel (0.75)	Museum/2 Weeks (0.75)	Winter (0.75)
London/Sydney (0.5)	House/Boat (0.5)	Sports/3 Weeks (0.5)	Spring (0.5)
Boston/Miami (0.25)	Boat/Tent (0.25)	Show/3 Days (0.25)	Fall (0.25)

and the opponent's emotional state (e.g., frustration or contentment). It aims to make offers close to a target utility, influenced by these factors. The robot initially focuses on the opponent's attitude and emotions but shifts its emphasis to time as the deadline nears. Additionally, the robots show predefined moods through specific gestures and arguments, using the frameworks from [6]. This system features advanced capabilities for real-time speech-to-text and text-to-speech interactions, enabling the integration of diverse negotiation strategies into different robots. All robots were fully autonomous and showed identical verbal behaviors and negotiation strategies, though slight differences in gestures existed due to hardware limitations (e.g., joint differences). While most studies on appearance focus on typological differences (e.g., human-vs. machine-like), we tested the effects of subtle differences among humanoids that are similarly anthropomorphic (Figure 1), with their overall human-likeness scores of 45.92, 42.17, and 45.65, respectively, in the ABOT database [25]. Nao and QT, but not Pepper, were placed on a table so that their faces were at the participant's eye level, and they all stayed at the same spot throughout the study.

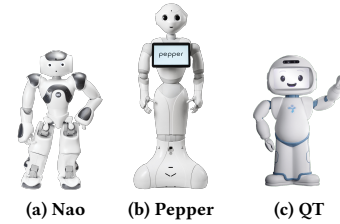


Figure 1: Appearances of The Robots

3.2 Methods and Procedure

As shown in Figure 2, each participant negotiated with two humanoid robots (Nao and Pepper in Study I and Nao and QT in Study 2). Before the negotiation sessions, participants completed the pre-negotiation survey (see the next section). The participant was seated facing the robot negotiation partner in the negotiation session. The participant then ranked the four negotiation issues (destination, accommodation, season, and event/duration) according to their priorities. During the negotiation session, participants could see their preference ranking, utility score, and elapsed time. Each session was limited to 15 minutes. A post-negotiation survey followed each of the two negotiation sessions. The order of the robot negotiation partners was counterbalanced across participants.

Pre- and post-negotiation surveys were administered on the online survey platform *Qualtrics*. The pre-negotiation survey was administered a day before the session, and it measured the first impressions of the robots through 8 questions, following [11]. The

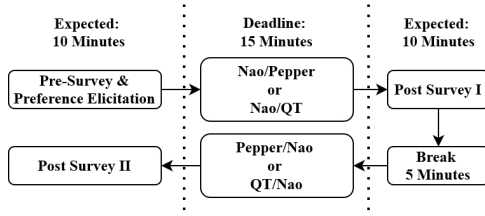


Figure 2: Experimental Procedure

post-negotiation survey asked about the participant's negotiation experience and their perception of the robot, measured through common scales such as the *Godspeed Questionnaire* [3] and *Feeling Thermometer* [9] (GQ and FT, respectfully). The Godspeed Questionnaire asked participants to rate the perceived animacy, likeability, intelligence, and anthropomorphism of the robot negotiation partner on a scale of 1-5. We also asked our participants to indicate how warm they felt toward the robot negotiation partner as well as the general categories of *social robots* and *robots* via FTs, which were on a scale of 0-100 (0 = extremely cold, 100 = extremely warm). In both studies, the data from the negotiation sessions and the surveys were statistically analyzed using dependent sample t-tests or the Wilcoxon-Signed Rank test (based on the Kolmogorov-Smirnov normality test and Levene's Test for variance homogeneity) and linear regressions. Results are reported with a 95% CI.

3.3 Study I: Nao vs. Pepper

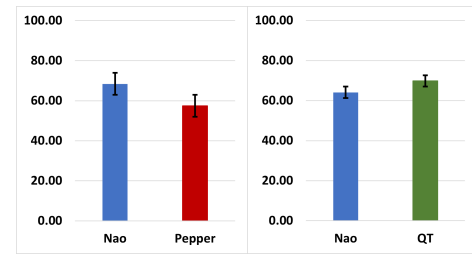
Study 1 compared Nao and Pepper, similar humanoids with some differences in height (58 cm vs. 120 cm), mobility (legs vs. wheels), and Pepper's unique feature of a chest-mounted tablet.

Conducted at Sabancı University, the study involved 55 participants (37 female, 18 male), comprising students and staff. Participation was voluntary, with an optional gift card as a potential reward. The university's ethics committee approved the study. Analyses were performed on pre-negotiation survey data, negotiation sessions, and post-survey results. Of the 55 participants, 52 were included in the utility score analysis (minimum two bids required). **Pre-negotiation survey:** Participants favored Nao over Pepper in their first impressions in the pre-negotiation survey ($M = 5.03$ vs. $M = 4.68$; $t(54) = 2.72$, $p = .009$). **Negotiation Outcomes:** Neither the participant's ($t(51) = .053$, $p = .958$) nor the robot's utility scores differed significantly between the two ($z = -0.780$, $p = .435$; Table 2). The two also did not differ in the negotiation duration ($M = 0.22$ for Nao and $M = 0.25$ for Pepper; $z = 1.221$; $p = .222$) and the number of rounds (12.87 rounds for Nao and 13.08 rounds for Pepper; $z = -0.238$; $p = .810$). **Post-negotiation survey:** Nao and Pepper did not differ in Animacy, Likeability, Intelligence, and Anthropomorphism of the Godspeed Questionnaire (all p 's $> .05$). However, participants felt significantly warmer toward Nao than Pepper (Figure 3; $M = 68.40$, $SD = 26.25$ for Nao and $M = 57.44$, $SD = 28.41$ for Pepper; $t(54) = 2.12$, $p = .039$). Among 55 participants, 33 reported they enjoyed negotiating with Nao more than with Pepper, and 30 indicated that Nao was better at dealing with Pepper, though the differences were not statistically significant ($\chi^2 = 2.20$, $p = .138$ for enjoyment; and $\chi^2 = .455$, $p = .500$ for negotiation ability). **Relationship between utility scores and felt warmth:** Two regression models tested

whether participants' first impressions of the two robots before the interaction gave insights into their utility scores and the warmth they felt toward the robots. The warmth model, but not the utility score model, reached significance (Adjusted $R^2 = .069$, $p = .003$) and indicated that participant's first impressions toward the robot were associated with how warm they felt toward the specific robot ($\beta = .279$, $SE = 1.97$, $p = .003$). Another pair of regression models also indicated that the first impressions significantly indicated warmth toward social robots ($\beta = .479$, $SE = 1.56$, $p < .001$) and general robots ($\beta = .465$, $SE = 1.62$, $p < .001$).

Table 2: The utility scores of the participant and robot in Studies I & II

Utility Score	STUDY I (N=52)				STUDY II (N=74)			
	NAO		PEPPER		NAO		QT	
	M	SD	M	SD	M	SD	M	SD
Participant	72.43	11.61	72.13	13.12	80.32	9.41	81.93	8.47
Robot	76.67	7.82	77.64	8.72	71.07	8.63	69.11	8.20



(a) Felt Warmth in Study-I (b) Felt Warmth in Study-II

Figure 3: Post-Negotiation Warmth of in Studies I & II

A regression model predicting the utility score with Godspeed ratings also reached significance (Adjusted $R^2 = .061$, $p = .033$), and Animacy positively correlated with the utility scores ($\beta = .380$, $SE = 2.60$, $p = .032$), and Intelligence negatively correlated with the utility scores ($\beta = -.287$, $SE = 2.01$, $p = .021$). Another model predicting warmth toward robots also reached significance (Adjusted $R^2 = .489$, $p < .001$), with Likeability as the only significant indicator ($\beta = .515$, $SE = 2.62$, $p < .001$). However, additional models found no significant interactions, including Robot Type (Nao vs. Pepper) and interaction terms (e.g., Animacy x Robot Type).

Overall, participants generally had a more favorable initial reaction to Nao than Pepper, which aligns with previous studies suggesting the importance of a robot's appearance in HRI. However, these differences in appearance did not translate into significant variations in the utility scores during negotiations, indicating that while the robot's look persistently impacts how participants feel about them, it doesn't necessarily affect negotiation outcomes. Interestingly, a higher level of animacy in the robot led to increased utility scores, suggesting that participants were more engaged in negotiations with robots that appeared more lifelike. On the other hand, the intelligence of the robot negatively impacted utility scores, potentially suggesting that participants felt intimidated or less competent when negotiating with a highly intelligent robot.

3.4 Study II: Nao vs. QT

To evaluate the generalizability of the Study I findings, Study II tested the same procedure with another robot, comparing Nao to QT. QT is similar to Nao in height but has an LCD screen head and a solid body with two joint arms. QT can execute a limited range of motions compared to Nao. Study II involved 74 participants (32 female and 42 male) and was conducted at Özyeğin University. The university's ethics committee approved the study.

Pre-negotiation survey: The first impressions of Nao and QT before negotiation were almost identical ($M = 4.49$ vs. $M = 4.50$; $t(73) = -.869$, $p = .388$), and no significant differences were found in felt warmth toward the robots either ($t(73) = -1.46$; $p = .148$). As in Study I, a regression model (Adjusted $R^2 = .044$, $p = .006$) indicated that participants' first impressions were significantly associated with the warmth ($\beta = .226$, $SE = 2.46$, $p = .006$). Yet, the utility model didn't reach significance. Another model pair found the first impressions also correlated with the warmth toward social robots ($\beta = .356$, $SE = 2.05$, $p < .001$), but not robots in general ($p > .05$). **Negotiation Outcomes:** As in the case of Study I, there was no significant difference in participants' utility scores in their negotiations with the two robots ($Z = -1.42$, $p = .156$). In terms of negotiation behaviors, the number of rounds to complete negotiations did not significantly differ, but unlike Study I, participants tended to reach agreements faster with Nao than with QT ($M = 0.34$ vs $M = 0.38$; $t(73) = 3.02$; $p = .003$). **Post-negotiation survey:** Overall, participants perceived Nao as more animate and anthropomorphic ($t(73) = 3.01$ and 3.13 ; $p = .004$ and $.003$). Further, 49/74 participants reported they enjoyed negotiating with Nao more than with QT, and this difference was found to be significant according to a Chi-square test ($\chi^2 = 7.78$, $p = .005$). Regression models predicting warmth with Godspeed ratings (but not with the utility score) reached significance (Adjusted $R^2 = .051$, $p = .022$). Likeability significantly, but negatively correlated with warmth ($\beta = -.200$, $SE = 3.11$, $p = .042$) while intelligence was positively associated with warmth ($\beta = .294$, $SE = 3.87$, $p = .004$).

4 DISCUSSION

The present work empirically investigated whether and how the appearances of robot negotiation partners affect negotiation outcomes and the participant's attitudes toward robots. We compared two pairs of robots, Nao vs. Pepper (Study I) and Nao vs. QT (Study II), to increase the generalizability of our findings. In Study I, the warmth felt toward Nao and Pepper significantly differed despite performing the same negotiation task. This pattern aligns with previous research on social acceptance with the two robots [30] and confirms that attitudes toward the interaction partner can change based on appearance. Less difference was found between Nao and QT in Study II, yet first impressions significantly correlated with warmth ratings in both studies. This finding suggests that the first impressions of robots persist over time. However, such effects of robot appearance did not extend to utility values in either study. Overall, our results indicate that the appearance of robots affects participants' feelings about their robot negotiation partner but not the outcomes. Consistent with virtual agent studies [26], our findings indicate that felt warmth and negotiation outcomes are independent. Even when the participant likes a robot, it does not necessarily translate to more effective negotiation outcomes. It is

also noteworthy that Nao was generally preferred more than Pepper or QT. Nao was perceived as more animate and anthropomorphic than QT, and participants generally preferred negotiating with Nao over the other two. These patterns may reflect our preference for lifelike qualities in social robots. On the other hand, likeability unexpectedly showed varying impacts on the warmth felt toward the robots, correlating positively with warmth in Study I and negatively in Study II. The key observations and implications of this study are:

- (1) First impressions affected the warmth felt toward the specific robot and social robots.
- (2) Animacy and perceived intelligence affected utility scores in Study I (but not in Study II).
- (3) The varied influence of likeability on warmth across the studies suggests there may be an untested moderating factor(s).
- (4) Lifelike robots, perceived as more animate and anthropomorphic, enhanced participants' enjoyment in negotiations.

These points highlight the complex relationship between a robot's physical appearance and perceived traits in negotiation contexts and emphasize the need to consider subjective perceptions and functional aspects in designing social robots. Despite the valuable insights gained from these studies, limitations must also be acknowledged. First, the negotiation task employed in our studies may only partially capture the complexity and diversity of real-world negotiation scenarios. Second, though we conducted testing in two different locations, most of our participants were students, and thus, the generalizability of the findings is still limited. Some differences between the two studies may be due to the differences in the tested samples. However, the within-subject design minimized the effects of individual differences within each study, and we kept the two datasets separated to avoid erroneous conclusions based on sample differences. The discrepancies observed necessitate further research to explore the interplay of various factors such as robot characteristics, participant backgrounds, and negotiation contexts.

5 CONCLUSION

The present study demonstrates the complex dynamics of human-robot negotiation and HRI. We found that while the appearance of robots significantly impacts first impressions and attitudes after interactions, those visual characteristics do not substantially affect the outcomes of negotiations. This observation was consistent across the two studies, comparing Nao vs. Pepper and Nao vs. QT. The observed differences and similarities in participants' responses underscore the multifaceted nature of human-robot negotiation and emphasize the need for further research on the interplay between human preferences, robot characteristics, and negotiation dynamics. The insights gained from these studies can contribute to a more profound understanding of HRI, offering broad implications for real-world applications where social robots are becoming essential.

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