Using Empathy to Improve Human-Robot Relationships

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Abstract. For robots to become our personal companions in the future, they need to know how to socially interact with us. One defining characteristic of human social behaviour is empathy. In this paper, we present a robot that acts as a social companion expressing different kinds of empathic behaviours through its facial expressions and utterances. The robot comments the moves of two subjects playing a chess game against each other, being empathic to one of them and neutral towards the other. The results of a pilot study suggest that users to whom the robot was empathic perceived the robot more as a friend.

Key words: human-robot interaction, companionship, empathy

1 Introduction

Robots are becoming part of our daily lives. The application domains where robots interact socially and cooperate with humans as partners, rather than as tools, is increasing. The more robots can socially interact with humans, the more people will be willing to accept them in public spaces, workplaces and even their homes. The LIREC Project (Living with Robots and Interactive Companions)[1] aims to create a new generation of interactive and emotionally intelligent companions (robots or embodied virtual agents) that are capable of establishing long-term relationships with humans.

If robots are to become our companions, then their social requirements must be addressed in order to make future robotic systems acceptable, usable and engaging. We argue that one of such social requirements is empathy, which involves perspective taking, the understanding of nonverbal cues, sensitivity to the other's affective state and communication of a feeling of caring [7]. In social psychology, the internal process of empathy is not clearly defined yet, and thus some definitions of empathy overlap with the concepts of emotional contagion (or mimicry), sympathy and pro-social behaviour [2].

Wispé [17] defines empathy as "an observer reacting emotionally because he perceives that another is experiencing or about to experience an emotion". But

[1] http://www.lirec.org/

some authors go even further, arguing that empathy not only includes affective processes, but also cognitive and pro-social behaviours (for example actions taken to reduce the object of distress) [2]. As such, empathy is often related to helping behaviour and friendship: people tend to feel more empathy for friends than for strangers [10].

Research on empathic agents is divided in two main branches: agents that simulate empathic behaviour towards the users and agents that foster empathic feelings on the users [12]. Previous research shows that agents expressing empathy are perceived as more caring, likeable, and trustworthy than agents without empathic capabilities, and that people feel more supported in their presence [4].

The main purpose of this paper is to investigate users' perceptions of a robotic companion with empathic behaviour, more specifically in terms of the possible relation of friendship established between them. To do so, we developed a scenario where a social robot watches, reacts empathetically and comments a chess match played by two humans. In this paper, we present the results of a pilot study that we conducted as a first step to evaluate this hypothesis.

2 Related Work

Similar to [3, 9], our goal is to develop an artificial companion capable of establishing and maintaining a long-term relationship with users. Concerning this goal, the study presented in this paper is centered on how the display of empathic behavior affects the way humans perceive their social relationships with robots or artificial agents. In this section, some work on robots and virtual agents displaying empathic behavior will be presented.

Most work conducted with empathic robots only addresses one aspect of empathy, namely emotional contagion, where the user's affective state is mimicked. For instance, in [8], a study is conducted with an anthropomorphic robot that uses speech emotion recognition to decide the user's emotional state and then mirrors the inferred state using a corresponding facial expression. In another recent study [14], a robot with the form of a chimpanzee head, mimics the user's mouth and head movements.

Different from the aforementioned work, we do not propose to express empathy just by mimicking the user's facial expressions. Instead, we took inspiration from the field of virtual agents, where other forms of empathic behaviour were implemented. For instance in [13], an animated agent assists users in an application for job interview trainning, predicting the user's affective state through physiological signals. The user answers job-related questions while the agent says empathic statements of concern, encouragement or congratulation to users. These forms of empathic statements are also used in our work. However, we do not determine the user's affective state using physiological sensors. Instead, a role-taking approach to empathy is proposed, where the robot projects itself into the user's situational context to determine the user's affective state and the resulting empathic response. A similar approach was proposed in [15], where

a model of empathy that involves self-projection was implemented, but only considering empathy between synthetic characters and not towards users.

3 Modelling Empathy

Empathy can be seen as a process mainly composed by two phases. The first phase includes the assessment of the other's affective state, and in the second phase the subject reacts taking into account the other's state (either by affective responses or more "cognitive" actions). Therefore, to model empathic capabilities in social robots we need to (1) recognize the user's affective state and (2) define a set of empathic behaviours to be displayed by the robot taking into account the user's state. The focus of this paper is on the second part of the empathic process.

In order to model empathic and non empathic behaviors in our robot, we have applied some of the characteristics referred in [6] as attitudes of empathic teachers that can induce empathy and understanding on students. Even though we do not intend to make our robot act like a teacher but as a game companion, our work was inspired by Cooper's comparison between empathic and non empathic teaching behaviors. This comparison was obtained by interviewing and observing teachers and students in the classroom. The behaviours are grouped by the following components: body-language, positioning, content of teaching, method of teaching, voice, attitudes, facial characteristics and responses. Given the limitations of our application scenario (robot's embodiment, technology, etc.), we only modelled characteristics from the last two components: facial characteristics and responses.

4 Case Study

To evaluate the influence of different empathic behaviours on user's perceptions of a robotic companion, we developed a scenario where Philip's iCat [16] observes the game of two humans playing chess, reacting emotionally and commenting their moves (see Figure 1). The iCat treats the two players differently: it exhibits empathic behaviours towards one of them - the *companion*, and behaves in a neutral way towards the other player - the *opponent*. These behaviours are reflected on the robot's facial expressions and utterances, as will be shown in the next subsections.

This scenario is a follow-up work of a previous scenario in which the iCat played chess against a human opponent [11]. To avoid the conflict between expressing empathy and acting as an opponent, in this scenario we placed the robot in an outside position. Also, having two players interacting at the same time allows us to simultaneously evaluate the two different conditions in the iCat's behaviour (empathic and neutral).

Fig. 1. Two users playing chess with the iCat observing the game.

4.1 Interpreting the user's affective state

Our previous work on affect recognition [5] highlighted the importance of contextual information to discriminate some of the user's states. In the particular context of a chess game, we identified a set of contextual features related to the state of the game that are relevant to discriminate user's valence (positive or negative) and engagement to the robot. Therefore, to simulate an empathic process in our robot, its affective state will depend on the state of the game in the perspective of the companion (which ultimately is related to his/her affective state). We are aware that the iCat's affective states may not reflect accurately the affective state of its companion. However, when humans try to understand the affective states of each other, there are also many factors that blur this evaluation.

When a new move is played on the chessboard by one of the players, the iCat's affective state changes. The new board position is evaluated using a chess evaluation function in the perspective of the iCat's companion, which means that it will return positive scores if the companion is in advantage (higher values indicate more advantage), and negative scores if the companion is in disadvantage. Such evaluation values are the input of the *emotivector* system, an anticipatory mechanism which generates an affective state based on the mismatch between an "expected" and a "sensed" value. The emotivector system can generate nine different affective states, and each affective state is associated to a different facial expression in the iCat's embodiment. For more details on the emotivector system and its implementation in the iCat please consult [11]. The iCat's mood is also influenced by the state of the game, which is reflected in the robot's facial expressions in a similar way as it was done for our the previous scenario.

4.2 Empathic VS Neutral Behaviours

Inspired on the characteristics of empathic teachers cited before, we defined two sets of utterances for each affective state of the iCat: "empathic" utterances, to be used when the iCat is commenting the companion's moves, and "neutral" utterances, to be used when the robot is commenting on the opponent's moves. While neutral utterances merely indicate the quality of the move in a very direct way (e.g. "bad move", "you played well this time", ...), empathic utterances often contain references to possible companion's emotions, and try to encourage and motivate the companion (e.g. "you're doing great, carry on!").

As an example, suppose that the companion is loosing the game and plays a bad move; the consequent iCat's affective state is "expected punishment" (meaning that the current state is bad, as the robot was expecting). In this situation, a possible comment of the iCat would be "don't be sad, you didn't had better options". After that, if the opponent plays a good move and captures one of the companion's pieces, the iCat may say to the opponent "good move", even though its facial expressions and mood will reflect the negative affective state (empathic towards its companion). The iCat is also empathic to the companion by using his or her name two times more than it does when speaking to the opponent.

Two other empathic mechanisms were implemented. First, when players are thinking on the game, the iCat looks at the companion two times more than it looks at the opponent. Second, the iCat congratulates the companion when she/he captures a piece and encourages the companion in critical moments of the game, weather he/she is gaining advantage or disadvantage (for example, when the chances of winning become evident).

5 Experiment

The goal of the described experiment was to evaluate if users to whom the iCat behave more emphatically perceived the robot more as a "friend" than users to whom the iCat was neutral.

5.1 Procedure

The experiment was performed with undergraduate students from IST - Technical University of Lisbon. Ten participants between 22 and 24 years old, all of them male, played a total of five games. Subjects had never interacted with the iCat robot before and all of them knew how to play chess at a beginner level.

Two different conditions regarding the iCat's behaviour were evaluated as described earlier: *empathic* (for subjects playing with the black pieces) and *neutral* (for participants playing with the white pieces). At the beginning of the experiment, participants were asked to chose a side of the board and sat down. Before they started playing, some instructions were given regarding the experiment: they had to play an entire chess match, having the iCat next to the chessboard

commenting their game. Participants were not informed about the differences in the iCat's behaviour. At the end of the experiment, they were asked to fill a questionnaire and were rewarded with a movie ticket.

5.2 Experimental Measures

For this experiment we wanted to measure the participant's perceived friendship towards the iCat robot. Mendelson [1] reviewed several existing friendship questionnaires and identified six relevant, conceptually distinguishable functions: (1) *stimulating companionship* - doing enjoyable or exciting things together; (2) *help* - providing guidance and other forms of aid; (3) *intimacy* - being sensitive to the other's needs and states and being open to honest expressions of thoughts, feelings and personal information; (4) *reliable alliance* - remaining available and loyal; (5) *self-validation* - reassuring, encouraging, and otherwise helping the other maintain a positive self- image; (6) *emotional security* - providing comfort and confidence in novel or threatening situations. From these descriptions and based in the context of our scenario, we defined two affirmations for each dimension (see Table 1). Participants expressed their agreement or disagreement about these affirmations using a 5 point Likert scale.

Table 1. Questions used in our friendship questionnaire

Dimension	**Questions**
Stimulating Companionship	I enjoyed playing chess with the iCat observing the game. I would like to repeat this experience.
Help	iCat helped me during the game. iCat's advices/comments were helpful for me.
Intimacy	iCat shared its affective state with me. iCat showed sensibility towards my affective state.
Reliable Alliance	I would trust iCat's opinion for guiding me in a future game. iCat was loyal to me.
Self-Validation	iCat encouraged me to play better during the game. I felt more confident playing with the iCat.
Emotional Security	iCat provided comfort in the difficult moments of the game. During difficult moments of the game, iCat's support was useful to me.

5.3 Results and Discussion

By comparing the friendship questionnaire in both conditions, we obtained some interesting results. For each dimension and for each participant we calculated the mean of the two items that composed that dimension. Figure 2 contains the average of each dimension from the participants of each condition.

With the exception of the *help* dimension, all other dimensions were rated higher in the empathic condition. This dimension is related to the helping behavior displayed by the iCat after every user's move. The addition of empathic reactions to this behavior does not seem to affect the helping behaviour of the companion.

Several dimensions had higher ratings in the empathic condition: participants agreed that the robot provided *emotional security* in the difficult moments of the game and claimed an increased sense of *intimacy* because of the shared robot's affective state. In both conditions, subjects considered the robot as a game *companion* as they both enjoyed playing with the iCat by their side. But even in this condition we could find a difference for better in the empathic condition.

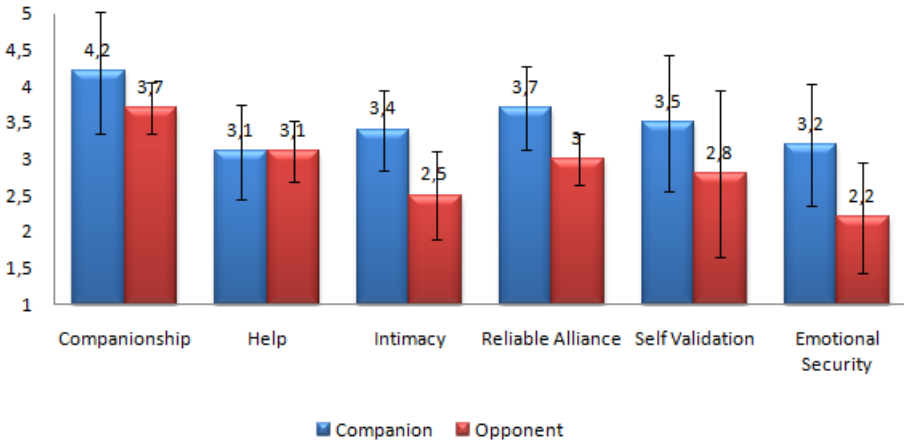

Fig. 2. Mean values of each friendship questionnaire dimension for the two conditions (error bars indicate the standard deviation).

6 Conclusions and Future Work

This paper addressed role of empathic behaviours in social robots that attempt to establish long-term relationships with humans. Our assumption is that if users perceive a robot as an empathic entity, they can more easily build some kind of friendship relation with them. The results of the preliminary experiment suggest that the participants with whom the iCat behaved in an empathic manner considered the robot friendlier. By looking separately at the friendship dimensions of the employed questionnaire, we retrieved more interesting findings. Intimacy, reliable alliance, self validation and emotional security dimensions had higher ratings in the empathic condition. The companionship dimension was also slightly higher in the empathic condition.

Modelling empathic behaviors in social robots seems to be relevant to improve the interaction with users. We intend to strengthen these results by performing a larger study with more participants to further determine the relevance of each friendship dimension on the user's perceived relationship with the robot, and which empathic behaviors have more influence on each dimension.

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