More Social and Emotional Behaviour may lead to Poorer Perceptions of a Social Robot

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Abstract. In this paper we present a study with an autonomous robot that plays a game against a participant, while expressing some social behaviors. We tried to explore the role of emotional sharing from the robot to the user, in order to understand how it might affect the perception of the robot by its users. To study this, two different conditions were formulated: 1-Sharing Condition (the robot shared its emotional state at the end of each board game); and 2-No Sharing Condition (the robot did not shared its emotions). Participants were randomly assigned to one of the conditions and this study followed a between-subject design methodology. It was expected that in the Sharing Condition participants would feel closer to the robot and would perceive/evaluate it as more human-like. But results contradicted this expectation and called our attention for the caution that needs to exist when building social behaviours to implement in human-robot interactions (HRI).

Keywords: Human-robot interaction, Emotional sharing, Social behaviour, Social robot.

1 Introduction

In every social interaction we are constantly aware and responsive to social cues from others. Those social cues tell us how to behave in response to how the others are acting and feeling. So, for robots to be integrated in humans' daily life activities, they have to be provided with similar social capabilities. Thus they need to be able to inform about the others about their intentions, their affective evaluations and often social stances.

It is commonly agreed that a social robot should be embedded with behaviours that enrich the interaction with humans, making such interaction natural and inspired in the way we humans interact with each other. Such behaviours can be non- verbal behaviours (e.g. gaze, gestures, emotion expression, posture, etc.) and verbal behaviours (e.g. small talk, emotion sharing- *"I am feeling sad"*, etc). However, although it is clear that the social behaviours are important, one needs to be cautious about the way these social capabilities are implemented, taking into account the situation, context and embodiment of the robot. For example, capabilities such as intention recognition, Theory of Mind, or emotion expression, may be perceived differently depending on the context in which the robot is going to be placed. One of the social cues that humans use is the sharing of emotions, which when done explicitly by humans, may lead to a sense of closeness in their relationships.

In this paper we report a study performed with a social robot that autonomously plays a competitive game and at the same time expresses certain social behaviours. By relying on an emotional agent architecture (using an appraisal mechanism) the robot was built with the capabilities of emotional appraisal and thus able to express and sharing its emotions verbally as the game unfolds. By sharing its emotional state, one may expect that the social bonds with the user can be reinforced, and thus affecting the way the robot is perceived. This paper describes the architecture that was built for the robot to autonomously appraise the situation in the game, generate emotional states and share the emotions with the user. In a study carried out with the robot we hypothesized that participants with whom the robot shared its emotions would perceive it more humanlike, more close to them, and with more friendlier characteristics. The results obtained, however, did not confirm these hypotheses, and in fact, some opposite findings were found. We report the results and discuss some justifications for these findings.

2 Related work

Humans are well equipped for social interactions, making it harder for a believable robot to successfully interact if it does not have similar social capabilities. In this sense it becomes very important to understand which capabilities better foster HRI and in which contexts they should emerge as more natural.

A way to fulfill this gap between technology and humans, is to enhance the anthropomorphic qualities (e.g. form and/or behaviour) of a robot, in order to create a way for humans to understand robots and vice-versa, necessary for a meaningful interaction[8]. Many studies reinforce this perspective, showing that a robot with social behaviour affects people's perceptions. For example, at a very basic level of communication, it is found that the presence of gestures in a robot catches more the user attention than without them[24], or that a robot can be seen as a companion, influencing people's perceptions of a shared event[12]. At a higher level it is also found, for example, that a socially supportive robot improves children learning, comparing to a neutral robot[22]. Indeed humans react to robots with social capabilities in a very positive way. A study from Kahn and colleagues(2015) even suggests that as more social robots become, people will probably build intimate and trusting relationships with them[13].

All this supports the fact that even small social behaviours affect HRI. Also, emotions play an important role in human behaviour, helping to form and maintain social relationships and establishing social position[9]. A study by Bartneck (2003) suggests that people enjoy more an interaction with an emotional expressive robot than a non-emotional [1]. And Becker (2005) comes to show how negative empathic behaviours are also important in a competitive game, though they are perceived as less caring by the user[3]. Therefore, emotions should also be taken into consideration when designing a social robot. The applicability of this can also be seen in Kismet's emotion and expression system, with the ability to engage people in affective interactions and so allowing it to be seen as a social creature[5].

Nonetheless, the context itself influences the perception of these behaviours and so they must be adapted to it. For example studies show that users cooperate more in an effortful task with a serious concerned robot, than with a playful robot (despite that they may enjoy more the playful robot)[10, 11]. Kennedy, Baxter and Belpaeme (2015) also tried to implement social behaviours in a robot and found these to negatively affect learning improvements in a task with a robotic social tutor, compared to a non social one. They hypothesize that could be due to a greater level of distraction in the social behaviour form[14]. Studies from Goetz, Kiesler and Powers (2003), support this, showing that people expect the robot to look and act according to the task context, increasing their compliance with it. So, a match between the robot social cues and its task influences people acceptance and cooperation with it[11]. All this reinforces the need to test and refine these behaviours according to the social interaction they are placed in.

3 An Autonomous Social Robot that Shares Emotions

Robotic game opponents and companions are recently being built for different scenarios and games such as chess [16], or risk [19]. These robotic game companions need to embed not only decision making capabilities (achieved with the adequate artificial intelligence modules) but also social aspects which may embed emotional appraisal, theory of mind, intention recognition and so on. In this research we created a system for a social robot (the Emys robot) that tries to embed these two components (decision making/playing and social) and explore the impact that these components have in the perceptions of the users.

The game considered is a variant of the dots and boxes game[4]. In this variant, called Coins and Strings, an initial board is created by a set of coins, and a set of strings connecting pairs of adjacent coins. Two players take turns cutting a string each time. When a player removes the last string attached to a coin, the coin is removed from the board and added to that player's coins, additionally the player will also have to play again (selecting another string to remove). The game ends when all strings are removed, and the player with the highest number of coins wins the game.

To create a social part of the robot in the context of a competitive game, we extended FAtiMA Emotional Agent Architecture [7] for that effect. In particular, to allow for the manipulation of specific embodiment features and synchronization, the architecture was integrated with Thalamus Framework [20], which was then interconnected with the game developed in Unity3D and with the robot Emys[15]. Figure 1 shows a diagram of the complete system. Thalamus is a component integration framework that provides the advantage of easily integrating a robotic embodiment with a virtual environment. Thalamus Master centralizes all communication between other Thalamus components using a action/perception publication and subscription mechanism.

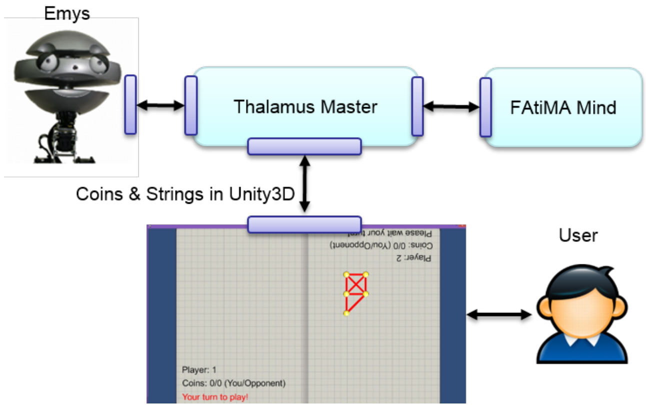

Fig. 1. Integration of FAtiMA, Thalamus and Emys to create the interactive system.

The system works as follows: when it's the user's turn to play, and he/she removes a string, the internal state of the game is updated in Unity, and a message about the event is sent (e.g user removed string number 3) to the Thalamus module. This message is perceived by a lower-level module, which will make Emys automatically look to the position of the removed string in the screen. At the same time, the Thalamus will send the same perception to FAtiMA, which updates its own internal state of the game, appraising the event and thus updating the robots emotional state. Both the updated emotional state and the play selected by FAtiMA are then sent to Thalamus. The emotional state is used to trigger emotion expression actions that are handled by Emy's Thalamus module, while the action will be sent to unity in order to update the state of the game. Emotion expression actions correspond to facial expressions that depending on the intensity of the emotion can also trigger speech, e.g. if a move caused Emys to be very happy, it will display a joyfull facial expression while saying "Great!".

Regarding the robot's cognitive and social behaviour, it was handled by FAtiMA linked with the decision-making component (AI for gameplaying). A standard Minimax algorithm [21] was implemented as a component in FAtiMA to decide the best move to play in the game. In addition, the Minimax value returned by the algorithm for a particular state (which represents the expected maximum utility) is used to predict the likelihood of winning the game, and also to determine the desirability of a particular event. The desirability of a game event is given by the change in the Minimax value caused by the event. As example, if the agent has a low Minimax value, but then the user makes a mistake and plays a bad move, the agent will update it's Minimax value to a much higher value, and the play will be appraised as very desirable. Since this is a zero-sum game, the Minimax value is also used to determine the appraisal variable *DesirabilityForOther* (with other being the user) by applying a negative sign to the desirability value. The mentioned appraisal variables are then used by FAtiMA to generate Joy/Distress/Gloating/Resentment/Hope/Fear emotions, according to OCC Theory of emotions[18]. Perceived events and internal intentions are stored together with associated emotions in FAtiMA's episodic memory. Each board played with the user corresponds to a singular episode.

In addition to expressing emotions, and playing the game, in the Emotion Sharing condition the FAtiMA agent has the goal to share past emotional episodes with the user. So after each game, the goal will activate, and it will use the autobiographic memory to automatically generate a textual description of the episode. Describing all events in a past episode would also make a boring, unrealistic conversation. Therefore, a summary of the episode containing the most relevant emotions is used. The summary of an episode consists in: the location where the episode happened; narrative time elapsed since the episode happened and a list of the most relevant events that happened in the episode, ordered by event sequence. The more relevant events are considered to be the ones that have generated a stronger emotional impact in the agent, and thus are determined by selecting the events with the strongest emotions associated to them. The chosen events are then ordered by event sequence, so that the summary generated follows a coherent narrative flow. In order to provide the user with information on the agent's personal experience about the past episode, we need to add to the event's description the emotion experienced when the event was appraised (e.g. *"You made an unexpected move and I felt upset"*).

For the transformation of the information in the episode summaries into text, a *LanguageEngine* is used. The episode summary is split into events consisting of one action and subject, and optional location, time, target, parameter and emotion elements. The text of an event is then generated by transforming these elements into text and combining them through rules. The single utterances are concatenated using a set of connectional phrases like *"and"*, *"then"*.An example of a generated summary is: *"Several minutes ago, I wanted to win the game which made me feel frightened. Afterwards I played an important move. I was feeling really glad."* For more details about this process, please consult [6]. Finally, the summary Speech Act Request is sent to Thalamus, which uses a off the shelf text-to-speech system to produce the dialog.

4 Methodology

4.1 Participants

In order to evaluate the developed autonomous robot concerning its social capabilities, regarding emotional sharing, a study was conducted with a Emys robotic head who autonomously played a game against a participant, while displaying some social behaviours.

A total of 30 university students took part of this study (22 male and 8 female), with ages ranging from 19 to 30 years old (M=23.4; SD=2.99). Participants were randomly allocated to one of two study conditions: Sharing Condition (where Emys after the end of each game board shared verbally its emotions with the participant) and the No Sharing Condition (where no emotional sharing was done). All participants signed a consent form in order to be part of the study and allowing for the sessions to be recorded. The sessions had a duration of approximately 20 minutes per participant (with 10 minutes of interaction with Emys) and took place in a Portuguese laboratory. The material used was a Lavalier microphone for audio recording and three cameras for video recording of the interaction.

4.2 Procedure

Upon arrival participants were assigned randomly to one of the two conditions. In the No Sharing Condition Emys social behaviours were only gaze tracking through a Microsoft Kinect and small talk during the game (e.g. *"This is going to be a hard game"*), on the Sharing Condition Emys maintained the social behaviours from the other condition and added a emotional sharing at the end of each board about its feelings regarding the result of the board (e.g. *"I was feeling worried, but then I was able to beat you"*). Each participant played five board games of the Coins and Strings game with Emys, where the difficulty increased with the board number, being board number one the easiest level. When the game was finished, participants were taken to another room where they filled a brief questionnaire (see Measures section).

4.3 Measures

To understand the impact of the emotional sharing social behaviour in the participants perception of the robot, the Godspeed Questionnaire [2] was applyed, with dimensions: Anthropomorphism, Animacy, Likeability and Perceived Intelligence.

In addition, since emotional sharing may lead to a closer relationship, by helping to form and maintain social relationships[9], we applied a connection questionnaire that was based on [23] consumer product attachment scale (adapted to refer to Emys, e.g. *"Emys is very dear to me"*) to explore the connection from the user to the robot. Also, we used the McGill Friendship Questionnaire (MFQ) [17], which comprises two questionnaires, one that measures the positive feelings regarding a friend and the other how much that friend fulfills six friendship dimensions: Companionship; Intimacy; Reliable Alliance; Self-Validation and Emotional Security (we did not use Help dimension since the game was a competition setting). These questionnaires were used in order to ascertain if Emys had a different impact on the participants depending on the condition they were allocated to. The Godspeed questionnaire was answered in a semantic differential scale as in [2], all other questionnaires were answered in a 5-point Likert scale ranging from *"Totally Disagree"* to *"Totally Agree"*.

5 Results

First we ascertained the internal consistency of the scales used and all had a good internal consistency. For the Godspeed questionnaire dimensions there were no significant differences found and the means were for the Sharing Condition and No Sharing Condition respectively: Anthropomorphism (M=2.53; M=3.18); Animacy (M=3.26; M=3.31); Likeability (M=3.31; M=3.49) and Perceived Intelligence (M=3.96; M=4.08).

Analyzing the items of each dimension, a Mann Whitney U Test was done and it was found a statistical significance between the conditions, for the Anthropomorphism dimension regarding the Unconscious/Conscious item (U=58, p=.010) and the Artificial/Lifelike item (U=65, p=.042). It is seen that participants perceived the robot as more conscious and lifelike in the No Sharing Condition (M=3.93, SD=0.70; M=3.27, SD=1.34) compared to the Sharing Condition (M=2.93, SD=1.22; M=2.33, SD=0.98), which goes against the expected results (see Fig. 2). For the Artificial/Lifelike item even though there was a statistical significance for the participants responses, these responses were only slightly more positive (less Artificial) in the scale for the No Sharing Condition. Also, for the Likeability dimension it was found a statistical significance for the item Awful/Nice (U=67,5, p=.05) where it is seen that participants perceived the robot as more nice in the No Sharing Condition (M=3.53, SD=0.74) than in the Sharing Condition (M=2.80, SD=1.01) (see Fig. 2). There were no other statistical differences in the other dimensions.

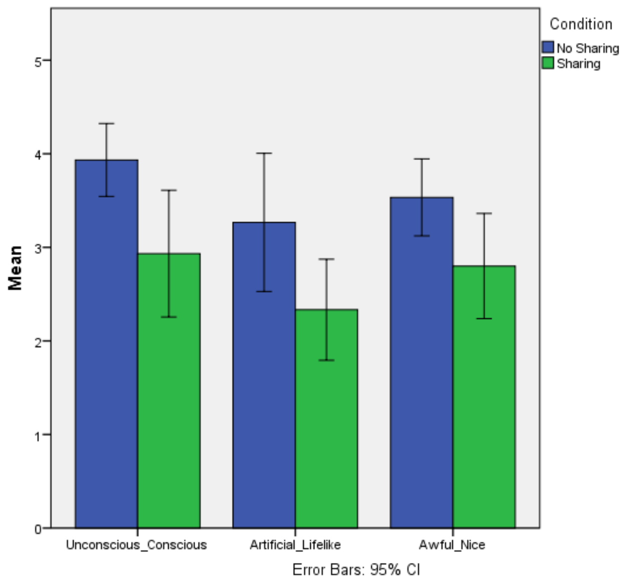

Fig. 2. Statistically significant results for the Godspeed Questionnaire in both conditions.

Even though there was no statistical significance for the Perceived Intelligence dimension, means show across conditions, that participants perceived Emys as very competent (M=4.40; M=4.47), knowledgeable (M=3.87; M=4.13) and intelligent (M=4.13; M=4.33), which clearly shows the high level of competence that Emys had in the game. This result is also supported by the winners of each session, as only 4 participants were able to beat Emys in the game.

For the Connection Questionnaire there were no statistical significant results. The mean answers for all the questions were around 2 and 3 in the scale, which seems to suggest that evaluating connection in this short-term interaction for this context is not an appropriate effect to be seen. The same happened with the McGill Friendship Questionnaire, with no statistical differences to report between conditions. In general Emys was seen as making participants laugh, as stimulating to interact with and very enjoyable.

6 Discussion and Conclusions

In this paper we tried to explore the role of emotional sharing from the robot to the user, in order to understand how this social capability might affect the perception of the robot by its users. Our hypothesis was that participants in the Sharing Condition (where the robot shared verbally its emotions at the end of each board game) would perceive the robot as more humanlike, more close to them and possibly with more friendly characteristics, compared to the participants allocated in the No Sharing Condition.

Surprisingly, the results did not support our hypothesis, showing that participants in the No Sharing Condition rated the robot as more Conscious, Lifelike and Nice. This seems to suggest that the emotional sharing that the robot performed was not giving the robot a more lifelike appearance. It is possible that its expression may not be taking the appropriate form in this concrete context. The highly competence that the robot presented in this task (only 4 participants were able to beat Emys) could have had an influence on participants perceptions, adding to the emotional sharing behaviour. In the Sharing Condition participants were subjected to emotional sharing phrases related to the game state at the end of each board game. As such, these autonomously generated phrases expressed positive emotions more frequently as the robot achieved its victories due to its high competence level. These emotional responses could in turn, we hypothesize, be highlighting more the vision of a machine, that always beats humans, than of a social robot that cares for the user. Which was also seen in the study of Becker [3] with the users feeling less care with the negative empathic approach.

Regarding connection and friendlier characteristics perceived in the robot, there were no significant differences between conditions. It could suggest that for this kind of short-term interaction in a competitive game this kind of bonding did not made much sense. It may be interesting to explore if these results change in the same context for a long-term interaction.

Remembering Goetz, Kiesler and Powers (2003) studies, participants in the Sharing Condition might be feeling that the robot emotional sharing dialogue is highlighting more an artificial kind of interaction, adding to its higher competence in the game (which it frequently wins). Whereas on the No Sharing Condition where only small talk happens, might be seen by participants as less artificial. Even though Emys still plays with the same high competence, there is no reinforcement of emotional sharing. Participants may feel a disconnection from the robot social behaviour and its task in the Sharing Condition. Due to the fact that emotional sharing in this context seems to be reinforcing negatively, giving a more artificial appearance to the robot and breaking social norms. These results have some similarity with the results obtained by Kennedy, Baxter and Belpaeme (2015), which found that improvement in learning with children is lost with a robotic social tutor, compared to a non social one [14]. It seems that by existing emotional sharing associated to a really high competence in the game, it is damaging the social interaction and perception of the robot by the users. Therefore, more research is needed in order to understand this relationship and how to better apply emotional sharing in HRI: what contexts it provides the robot with better social capabilities, and in which it should be avoided.

These findings suggest important implications for the design of social behaviours necessary to exist in an autonomously social robot. It calls our attention for the fact that more may be less if not properly adjusted to the context where it gains form. Further studies will be conducted in order to try and clarify the role of emotional sharing in social interactions between robots and users.

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