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More May Be Less: Emotional Sharing in an Autonomous Social Robot

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Abstract

We report a study performed with a social robot that autonomously plays a competitive game. By relying on an emotional agent architecture (using an appraisal mechanism) the robot was built with the capabilities of emotional appraisal and thus was able to express and share its emotions verbally throughout the game. Contrary to what was expected, emotional sharing in this context seemed to damage the social interaction with the users.

It is commonly agreed that a social robot should be embedded with behaviours that enrich the interaction with humans, with the goal of being as natural as possible and inspired in the way we humans interact with each other. However, implementing social capabilities needs to be a cautious process, taking into account the situation, context and embodiment of the robot.

In our study we created two conditions: Sharing condition (where the robot at the end of each board game shared verbally its emotions toward the game) and No Sharing (the robot did not share its emotions) and we formulated the hypothesis that participants with whom the robot shared its emotions would perceive it as more humanlike (less artificial), more close to them, and with more friendlier characteristics.

Social Behaviours in HRI

A way to bridge the communication gap between technology and humans, is to enhance the anthropomorphic qualities of a robot, fomenting a mutual understanding, necessary for a meaningful interaction (Duffy 2003). Various studies reinforce this perspective, showing that a robot with social behaviours affects people's perceptions. For example, at a basic level of communication, it is found that the presence of gestures in a robot catches more the user attention than its absence (Sidner et al. 2005), or that a robot can be seen as a companion, influencing people's perceptions of a shared event (Hoffman and Vanunu 2013). At a higher level of communication it is also found, for example, that a socially supportive robot improves children learning, comparing to a neutral robot (Saerbeck et al. 2010). A study from Kahn and colleagues(2015) even suggests the more social robots become, probably, the more people will build trusting and intimate relationships with them (Kahn Jr et al. 2015). This way it can be seen, that even small social behaviours affect human-robot interaction (HRI). Also, emotions play an important role in human behaviour, contributing for the creation and maintenance of social relationships (Fischer and Manstead 2008). For this reason, they should also be taken into consideration when designing a social robot (for example, Kismet's emotion and expression system (Breazeal 2003) or a study by Becker (2005) showing that negative empathic behaviours are also important to exist in a competitive interaction, despite the fact that they seem to reflect a less caring image toward the robot (Becker et al. 2005)).

However, the context has an important effect, influencing the perceptions of these behaviours. A simple example is a study showing users cooperating more in an effortful task with a serious concerned robot, than with a playful robot (despite that they may enjoy more the playful robot) (Goetz and Kiesler 2002; Goetz, Kiesler, and Powers 2003).

Kennedy, Baxter and Belpaeme (2015) also tried to implement social behaviours in a robot and found these to affect negatively learning improvements in a task with a social robotic tutor, compared to a non social one (Kennedy, Baxter, and Belpaeme 2015). Goetz, Kiesler and Powers (2003) studies show that people expect the robot to look and act accordingly to the task context, increasing their compliance with it. (Goetz, Kiesler, and Powers 2003). All of this reinforces the need to test and be cautious when implementing these behaviours.

An Autonomous Social Robot that Shares Emotions

In this research we created a system for a social robot (the Emys robot) that tries to embed 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 (Berlekamp 2000), called *Coins and Strings*. Players take turns removing strings. The player who removes the last string attatched to a coin collects the coin and will play again. 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 (Dias, Mascarenhas, and Paiva 2014). In particular, to allow for the manipulation of specific embodiment features and synchronization, the architecture was integrated with the Thalamus Framework (Ribeiro et al. 2014), which was then interconnected with the game developed in Unity3D and with the robot Emys (Kdzierski et al. 2013).

Regarding the robot's cognitive and social behaviour, it was handled by FAtiMA. A Minimax algorithm (Russel and Norvig 2002) was integrated into FAtiMA as a component in order to determine the next move to play, but also to calculate a set of appraisal variables based on the state of the game. For instance, an estimation of the final score (the Minimax value) is used as the desirability. The resulting appraisal variables are then used to generate emotions according to OCC Theory of emotions (Ortony, Clore, and Collins 1998). As example, a negative desirability will generate a distress emotion. Generated emotions are then expressed using EMY's facial expressions and will sometimes trigger small utterances such as "Great!".

Perceived events and internal intentions are stored in FAtiMA's episodic memory and associated to the emotions generated by them. For each board played a singular episode in episodic memory will be created, which contains all events occurred and their corresponding emotions. In the Sharing emotion condition the FAtiMA agent has an explicit goal to share past emotional episodes with the user. So after each game, the goal will activate, and it will use the last episode stored in episodic memory to automatically generate a summary of the episode. The summary is created by selecting the events associated to the strongest emotions, retrieving both the event and the emotional information stored with them, and using a Language Engine with a set of grammatical rules to generate the summary text (e.g. *"I was feeling worried, but then I was able to beat you"*, for more details see (Dias et al. 2007)). Finally, the text is sent to Thalamus that uses a standard text-to-speech system to create the spoken dialog.

Study Methodology

30 participants (university students) took part in this study (22 male and 8 female), with ages ranging from 19 to 30 years old (M=23.4; SD=2.99). Participants were assigned randomly to one of two conditions: the No Sharing Condition (social behaviours were only gaze tracking through a Microsoft Kinect, which allowed the robot to look at the user and at where the user would play, facial expressions of emotions, and small talk during the game (e.g. *"This is going to be a hard game"*) and the Sharing Condition where Emys maintained the social behaviours from the other condition and added a emotional sharing at the end of each board about the events and its feelings regarding the result of the board. Each participant played five board games of the *Coins and Strings* game with Emys, where the difficulty increased with the board number. The sessions had a duration of approximately 20 minutes per participant (with 10 minutes of interaction with Emys and the rest filling the questionnaires) and took place in a Portuguese laboratory. To understand the impact of the emotional sharing social behaviour in the participants perception of the robot, the Godspeed Questionnaire (Bartneck et al. 2009) was applyed in order to ascertain if the users perception of the robot regarding the Godspeed dimensions (the ones used were Anthropomorphism, Animacy, Likeability and Perceived Intelligence) would change with the presence of emotional sharing or not. In addition, since emotional sharing may lead to a closer relationship, by helping to form and maintain social relationships(Fischer and Manstead 2008), we applied a connection questionnaire that was based on Schifferstein and Zwartkruis-Pelgrim (2008) consumer product attachment scale (adapted to refer to Emys, e.g. *"Emys is very dear to me"*) to explore the closeness from the user to the robot and if it would be higher in the Sharing condition (Schifferstein and Zwartkruis-Pelgrim 2008). Also, we used the McGill Friendship Questionnaire (MFQ) to ascertain levels of friendship towards the robot in both conditions (Mendelson and Aboud 1999). 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 (Bartneck et al. 2009), all other questionnaires were answered in a 5-point Likert scale ranging from *"Totally Disagree"* to *"Totally Agree"*.

Results and Conclusions

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

Regarding the Godspeed questionnaire dimensions, participants mean answers 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). Since no normality was found non parametric tests were used, so a Mann Whitney U test was done but no significant difference was found between conditions for the dimensions. However by analyzing each question individually with a Mann Whitney U test, significant differences were found for two questions belonging to the Anthropomorphism dimension: Unconscious/Conscious (U=58, p=.010, r=-.47) with an effect size ranging close to a strong effect (almost 0.5), and Artificial/Lifelike (U=65, p=.042, r=-.37). Where it was seen that participants perceived the robot as more conscious and lifelike in the No Sharing Condition (Mdn=4 for both) and means (M=3.93, SD=0.70; M=3.27, SD=1.34) compared to the Sharing Condition (Mdn=3; Mdn=2) and means (M=2.93, SD=1.22; M=2.33, SD=0.98) And one question for the Likeability dimension: Awful/Nice (U=67.5, p=.05, r=-.36) where participants perceived the robot as nicer in the No Sharing Condition (Mdn=4) and mean (M=3.53, SD=0.74) than in the Sharing Condition (Mdn=3) and mean (M=2.80, SD=1.01).

Surprisingly, the results did not support our hypothesis, suggesting that participants in the No Sharing Condition rated the robot as more Conscious, Lifelike and Nice. It seems that the emotional sharing performed was not giving the robot a more lifelike appearance. Regarding connection and friendlier characteristics perceived in the robot, there were no significant differences found between conditions, which might suggest that more interaction time may be needed for this ”bonding” to emerge.

The highly competence that the robot presented (only 4 participants were able to beat Emys), adding to the emotional sharing behaviour could have had an influence on participants perceptions. In the Sharing Condition participants were subjected to emotional sharing utterances related to the game state at the end of each board game. As such, these autonomously generated utterances expressed positive emotions more frequently towards the robot as it achieved its victories.

Remembering Goetz, Kiesler and Powers (2003) studies, participants in the Sharing Condition might be feeling that the robot emotional sharing dialogue is reflecting a more kind of artificial interaction, adding to its higher competence in the game (which it frequently wins). Which might come close to the results obtained with Becker (2005) and a less caring image toward the robot. Whereas on the No Sharing Condition where only small talk happens, might be seen by participants as less artificial. Despite the fact that Emys still has the same high competence, there is no reinforcement of emotional sharing. These results have some similarity with the results obtained by Kennedy, Baxter and Belpaeme (2015), which found out that improvement in learning with children is lost with a robotic social tutor, compared to a non social one (Kennedy, Baxter, and Belpaeme 2015). It appears that by existing emotional sharing associated to a really high competence in the game, a damage occurs to the social interaction and perception of the robot by the users.

Vision

More research is needed to understand how to better apply emotional sharing in HRI and in what contexts it is advantageous to the robot and in which it should be avoided. Further studies will be conducted in order to better understand the role of competence and emotional sharing in a competitive game.

These findings suggest important implications for the design of social behaviours. It calls our attention for the fact that *more may be less* if not properly adjusted to the context where it gains form.

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