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Emotional Sharing Behavior for a Social Robot in a Competitive Setting

Sofia Petisca[1], João Dias[1], Patrícia Alves-Oliveira[2] and Ana Paiva[1]

***Abstract*— Is a robot that shares explicitly its emotions with users more believable and friendly? In a previous study addressing this question, results suggested that an emotion sharing feature in a robot may have negative effects in the perception of that robot. Here, we address the same question but also take into account the "competence" of a robot executing a task, to understand if some kind of interaction occurs.**

To understand if emotional sharing could bring changes to the participants perceptions towards an autonomous robot that played a game against them, we performed two studies. In the first study, the robot had a high competence in the game and in the second a low competence. In each of these studies two conditions were formed: Sharing Condition (the robot would do small talk and comment on its feelings regarding the result of the board) and No Sharing (the robot would only do small talk). Participants were randomly assigned to one of the conditions following a between-subject design methodology.

We expected that in the Sharing Condition, participants would feel greater involvement with the robot changing their perceptions towards it in contrast with the less caring and emotionally limited condition. The results of the studies did not follow what we expected, neither an interaction was found with the competence level. Still some interesting results were seen.

I. INTRODUCTION

Emotions play an important role in human interactions. They affect our decision making processes, our perceptions and our non-verbal behavior. In social interactions, people not only display their emotions in an almost automatic way, but they share them explicitly, either as a response to the others, or because it has a purpose in the interaction. If for example someone shares a private bad moment with another, the relation may change as a result, making people feel more close to each other. When creating social robots, emotion sharing can also be part of the interaction. People may in fact share their emotions with a robot, and robots on the other hand may share explicitly some emotional state with a user. Yet, in order to do so, robots need to be endowed with an emotional system that makes the robot able to understand and respond to the human emotions.

Significant work has been done on creating emotion expression systems (see for example the case of Kismet [1]), enriching the robot's presence and making it a more social creature. Indeed, people seem to enjoy more to interact with an emotional expressive robot, than a non-expressive one[2]. Yet, responding emotionally is not the same as sharing explicitly, through language, one's emotional state.

So, the main question driving this research is: does the sharing of emotions by a robot in an explicit way makes the robot more friendly and believable?

Having this in mind, we report two studies that were performed with a social robot that autonomously plays a game against a participant. We created two conditions: in one condition the robot shared its emotions towards the game unfolding, and on the other one it did not.

Our primary goal was to see if the users' perceptions of the robot would change depending on the presence or not of the emotional sharing behavior, expecting that this behavior would bring a greater sense of closeness and presence towards the robot. Ultimately and in a very exploratory way, we added a question that the robot would do towards the last game: *"Would you let me win the next board, please?"* we expected participants to show a greater prosocial behavior in the Sharing Condition, by letting the robot win the last board of the game regardless of the other boards results.

Taking into account previous results [3] where negative effects were seen in the same task with a robot expert at playing, we added a new variable: the robot competence. What happens if the robot is very good (or not so good) at performing a task? Is the response to the emotion sharing by the robot dependent of its competence? So we performed a first study where the robot had a high competence in the game (just like the study we already did before but now with the improvements) and a second study where the robot had a low competence in the game. This way, we tried to understand if the level of competence was indeed affecting the user perceptions together with the emotional sharing behavior. The results helped us to better understand the effects of emotion sharing and competence level in this competitive scenario, and further raised some interesting observations that are discussed.

II. RELATED WORK

Increasingly, emotions have been gaining more space in the robotics field, with its value being recognized for human and robot interactions. Indeed, it is emotions that enable us to feel closer to other humans and develop effective relationships.

Various systems have been developed in order to account for different social cues of others in order for the robot to be able to adapt to it and respond better accordingly (e.g.[4], [5]). However, it is also important to give emotions to the robot in order to smooth the communication with humans and inform about the robots intentions and needs (e.g.[1]).

[1]Sofia Petisca, João Dias and Ana Paiva is with INESC-ID & Instituto Superior Técnico, Universidade de Lisboa {sofia.petisca}{ana.paiva}@inesc-id.pt, joao.dias@gaips.inesc-id.pt

[2]Patrícia Alves-Oliveira is with INESC-ID and Instituto Universitário de Lisboa (ISCTE-IUL), CIS-IUL, Lisboa, Portugal patricia.alves.oliveira@inesc-id.pt

If we think of a short and simple interaction, as a game, a lot of social cues happen (verbally and non-verbally). So when we think about human-robot interactions those social cues are important to be in place. There are many examples that show how these social capabilities make a difference in the interaction (e.g. [6], [7]). For example, in a competitive setting where two players battle for the winner place it is even found that negative empathic behaviors are important to happen in the robot behaviors, since these make sense for the interaction [8]. By providing these social features we are hopefully enriching the social interaction and fostering a more life-like presence to the robot.

With this in mind, we have implemented an emotional sharing component whereby a robot externalizes explicitly its emotions, not only through facial expressions but also by using verbal comments regarding its feelings towards the game unfolding. As with people the process of self-disclosure (revealing information about themselves to others) is viewed as important for the sense of closeness to someone and for the creation of stronger relationships [9]. In HRI (human-robot interaction) an experiment run by Imai and Narumi (2004) showed that affective utterances influenced the level of compliance from humans towards a robot request, showing a greater level of involvement in the interaction[10]. Following that we expected that an emotional sharing element in a robot would therefore lead to a greater involvement, despite the presence of a competitive scenario.

III. The System

The setting chosen for the emotion sharing work is a game, where the user plays and interacts with a robotic agent in a competitive manner. The game considered is a variant of the dots and boxes game [11], called Coins and Strings. Players take turns removing strings. The player who removes the last string attached 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 the FAtiMA Emotional Agent Architecture [12] for that effect. The architecture was integrated with Thalamus Framework [13], which was then interconnected with the game developed in Unity3D and with the robot EMYS[14] as depicted in figure 1. When the user removes a string, the internal state of the game is updated in Unity, and a message about the event is sent 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. A standard Minimax algorithm [15] was implemented as a component in FAtiMA to decide the best move to play in the game. 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 algorithm will update it's Minimax value to a much higher value, and the play will be

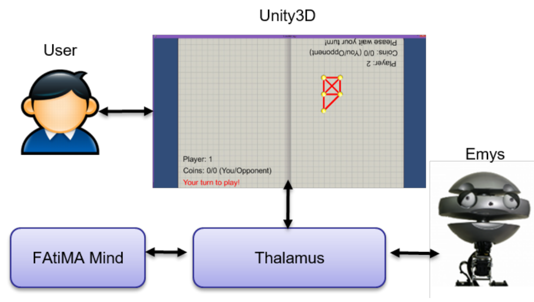

Fig. 1. Integration of FAtiMA, Thalamus and Emys to create the interactive system.

appraised as very desirable. Appraisal variables such as this are then used by FAtiMA to generate emotions, according to OCC Theory of emotions[16]. 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. The emotional state is used to trigger emotion expression actions that are handled by EMY's. 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 joyful facial expression while saying "Great!".

Additionally to expressing emotions, in the Emotion Sharing condition the FAtiMA agent has the social goal of sharing 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 summary of the episode describing the most relevant events. 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 more details on the system, please refer to [3].

Given previous results, the system was endowed with episode summaries converted into text created from a set of templates for possible combinations of episode summaries (an episode summary usually consists in two to three events with an emotion associated to one of them) guaranteeing the naturalness of the interaction. We relied on previous work to come out with natural sentences that were then parameterized according to the state of the game and the emotional state of the agent. During run-time, whenever a new episode summary is generated, the system finds the closest template and selects a good sentence from the ones available for the template. Further, to guarantee the naturalness of the interaction, the system performs emotion sharing in a gradual manner, and not all the time. Thus giving the notion that emotion sharing is something one does if the social link with each other is strong.

Finally, our aim was also to explore how the degree of competence in the game affected the perception and response to the emotional sharing by the robot. So, we additionally created a version with low competence, changing the minimax algorithm to only consider a depth of one, meaning that the algorithm will only consider one move ahead, while the high competence version considers 4 to 5 moves ahead (depending on available time).

Fig. 2. Playing Coins and Strings game against Emys.

IV. Methodology

With the system improvements, studies were conducted using EMYS robotic head who autonomously played the Coins and Strings game against a participant (see Figure 2).

We performed two studies in order to ascertain the role of competence on the emotional sharing behavior perceived by the participants. In Study 1, the EMYS robot had a high competence when playing the game and in Study 2, EMYS had a low competence in the game. In each study there were two conditions: the "Sharing Condition" (where EMYS did small talk and shared at the end of the board its feelings towards the results); and the "No Sharing Condition" (where EMYS did not share its feelings throughout the interaction, yet it still did some small talk). Since in previous studies EMYS seemed to be talking too much in the Sharing condition we guaranteed that the emotional sharing was limited and the robot did not talk more.

A. Participants

For Study 1 we had a total of 55 university students (43 males and 12 females) with ages ranging from 18 to 32 (M=22.93; SD=3.22). For Study 2 we had a total of 36 university students (26 males and 10 females) with ages ranging from 18 to 34 (M=22.67; SD=3.67). Participants from both studies were randomly allocated to each condition and none were repeated across studies.

All participants signed a consent form in order to be part of the study and for the sessions to be recorded in order to have video analysis afterwards. The sessions took approximately 20 minutes per participant (with 15 minutes interaction with EMYS) and were done in a Laboratory in Lisbon. The material used was a Multitouch table, a Lavalier microphone for audio recording if participants decided to interact verbally with EMYS and two cameras, one for the participant and another one catching the whole interaction. Below we present the Procedure and Measures that were the same for both studies.

B. Procedure

When arriving to the Laboratory, participants were randomly assigned to one of the two conditions. In both conditions EMYS did some small talk during the game (e.g. *"This is going to be a hard game."*). In addition, for the Sharing Condition, EMYS commented in the end of some boards how it felts towards the result of it (e.g. *"I actually wanted to win you in this board, but because I was so anxious I totally failed."*; *"I was distressed because I initially did a bad move. Fortunately, I managed to win despite that, it was nice."*).

Each participant played five board games and the difficulty was increasing accordingly. At the end of the fourth board (regardless of the study or the conditions) EMYS asked the participant if he/she would let him win that last game, then the game followed as before. When the game was finished participants were taken to another room in order to fill the questionnaires (see Measures section).

At the end of the experiment participants received a movie ticket as a thank you for participation.

C. Measures

The PANAS questionnaire[17] was used, where we asked each participant to rate (from 1- *Nothing* to 5- *A lot*) how much of a series of positive and negative affect did they felt in EMYS. This measure was used with a validated adaptation for the Portuguese population[18] and aimed to clarify if the emotional sharing behavior was being perceived by the participants, and so it would be hoped that its values would be much higher in the Sharing Condition.

The Godspeed Questionnaire[19] was applied in order to understand if participants perceived EMYS differently according to the condition they were allocated to. So participants answered to the Anthropomorphism, Animacy, Likeability and Perceived Intelligence dimensions in a semantic differential scale of 7 points.

A User Acceptance Toolkit (Almere)[20] was also used to account for possible differences found between the conditions regarding the social interaction. This toolkit devises itself into 11 dimensions but we only thought relevant to use the following 5 dimensions: Trust (e.g. *"I would trust Emys if it gave me advice"*); Perceived Sociability (e.g.*"I find Emys pleasant to interact with"*); Social Presence (e.g.*"Sometimes Emys seems to have real feelings"*); Perceived Enjoyment (e.g.*"I find Emys enjoyable"*) and Intention to Use (e.g.*"I would like to play again with Emys in the following days"*). A total of 20 items were answered with all item-dimension shuffled, in a 7-point Likert scale, ranging from *"Totally disagree"* to *"Totally Agree"*.

Next, an Empathy questionnaire was applied, adapted from Davis(1980) Interpersonal Reactivity Index[21] using only two of the four dimensions available: Perspective Taking- the tendency to adopt the psychological point of view of others (e.g. *"I think in a disagreement, Emys would try to see both sides before making a decision"*) and Empathic Concern-other-oriented feelings of sympathy and concern for others (e.g.*"I think Emys would protect someone if it saw they were being taken advantage of"*).Since these two were the ones that would make more sense for this kind of interaction with the robot. This questionnaire was comprised of 13 items and its goal was also to try and see if owing to the emotional sharing behavior, participants would see EMYS differently. It was rated the same way as the other questionnaires.

Finally, we asked participants regarding the last question EMYS made in the fourth board (*"If they would let EMYS win"*) to choose one of the following options: if they lost the last game, to let EMYS win; if they lost the game, but they did not wanted to let EMYS win and if they just won the game. This was an attempt to try and see if the emotional sharing could also have a role in participants letting EMYS win the last game, regardless of what happened in the rest of the boards.

D. Video Analysis

In order to ascertain other effects that could be happening and could miss the self-reported measures, we proceeded to do video analysis of the sessions. A total of 16 hours and 23 minutes of video sessions was annotated. The coding scheme was comprised of:

- Looks at (EMYS/task/elsewhere);
- While looking (EMYS is talking/EMYS is not talking);
- EMYS Speaks;
- Talking (to EMYS/to himself).

Two coders annotated fifty percent of the data to find out the level of agreement of the coding scheme used, using Elan Tool[22]. And the Cohen's Kappa revealed k=.70, ρ=.00, being a good agreement between coders. One of the coders proceeded to code the remaining videos. With this coding we reported how much time the participant: looked at EMYS (and if EMYS was speaking or not when they looked), looked at the task; EMYS spoke; and if they talked during the task (to themselves or towards EMYS).

V. Results

A. Comparing Study 1 versus Study 2

To understand the influence of our two independent variables: Condition (Sharing and No Sharing) and Competence (High and Low), two-way ANOVAs were performed in order to find out if there was an interaction between our independent variables or main effects.

1) PANAS Questionnaire: For the positive affect reported there was no significant interaction found between our two independent variables. However a significant main effect was found for the Condition on the positive affect reported, F(1, 87)=3.88, ρ=.05. It can be seen that more positive affect is reported in the Sharing Condition (M=30.34), since it was in this condition that the sharing behavior was taking place, contrary to the No Sharing Condition (M=27.35). Also, there is a significant main effect for the Competence level on the positive affect, F(1, 87)=6.63, ρ=.01. Showing that participants perceived more positive affect in the High competence (M=30.80) than in the Low competence (M=26.89). These results make sense, when EMYS had a high competence, it won most of the games (EMYS won 44 games and only 11 participants defeated him) hence showing more positive emotions.

For the negative affect there was also no significant interaction between the two independent variables. But also as for the positive affect, there was a significant main effect for the Condition, F(1, 87)=4.87, ρ=.03, once more with more affect reported in the Sharing Condition. Finally, there was a significant main effect for the Competence level on the negative affect, F(1, 87)=17.89, ρ=.00. Showing that participants perceived more negative affect in the Low Competence (M=18.95) than in the High Competence (M=14.18). Following the previous results in the Low Competence EMYS lost more games (participants won 33 games and EMYS only won 7 games) and so showed more negative emotions. Nevertheless, it should be noted that for this variable the homogeneity assumption was not met (ρ=.02).

2) Godspeed Questionnaire: For the Anthropomorphism, Animacy and Likeability dimension there was no significant interaction found neither main effects, showing that participants across our independent variables did not feel differently towards EMYS. For the Perceived Intelligence dimension we did not found a significant interaction. Yet, there was a significant main effect for Competence, F(1, 87)=7.84, ρ=.01, showing that participants gave higher scores in the High Competence (M=5.41) comparing to the Low Competence (M=4.85), which supports the Competence variable included in EMYS. Still, it is of notice that for this dimension the homogeneity assumption was not met (ρ=.02).

3) Almere Questionnaire: There was no significant interaction found neither main effects with the Almere Questionnaire, showing that participants did not felt differently towards EMYS in respect to the Almere dimensions. However, the dimensions "User Enjoyment" and "Intention to Use", presented in both studies an average score of 6 which shows that in general participants enjoyed interacting with EMYS and would like to have that interaction more times.

4) Empathy Questionnaire: In the Perspective Taking dimension, there was no significant interaction found or significant main effects. For the Empathic Concern dimension also no significant interaction, but a significant main effect for the Competence was found, F(1, 87)=7.09, ρ=.01. Showing that participants gave higher scores of Empathic Concern in the Low Competence (M=4.54) comparing to the High Competence (M=3.78) level.

This is interesting, suggesting that this effect may be happening because EMYS in the Low Competence is showing much more negative affect for losing more games, and this may be influencing participants answers on this dimension.

5) Video Analysis: Our reported data from the questionnaires revealed some interesting facts about emotional sharing in a robot. Yet, the results were not completely in line with what we expected, nor revealed indeed the impact that emotional sharing might have on the participants. So, we analyzed the 91 participants videos hoping that it could bring some unconscious behaviors towards EMYS.

Most of the time participants were looking at the task, which shows a good engagement with the game, but here we will report the most relevant aspects of our coding, which were: the amount of time they looked to EMYS and if that happened more when EMYS was not talking (to try and understand if there was really more attention given to EMYS or just an effect of EMYS speaking more as reported before) and the amount of time participants talked either with EMYS or themselves.

Regarding the feature gazing at robot no significant interaction was found, but a significant main effect for Condition appeared, F(1, 87)=21.37, ρ=.00, suggesting that participants looked more at EMYS in the Sharing Condition (M=37.41) comparing to the No Sharing (M=20.73) one. However, we need to be careful in interpreting this result because there is also a significant main effect for the condition regarding the amount of time that EMYS spoke, F(1, 87)=1186.29, ρ=.00. Showing that in spite of our efforts to reduce the amount of emotion sharing done, and increase the amount of time EMYS spoke in the No Sharing condition, in reality it spoke a little bit more in the Sharing Condition (M=75.81) compared to the No Sharing (M=37.90).

Regarding competence only, EMYS significantly spoke more in the High Competence (M=61.75) comparing to the Low Competence (M=51.95). Also a significant main effect was found for the Competence level, F(1, 87)=17.21, ρ=.00, showing that participants looked more to EMYS in the Low Competence (M=36.56) than in the High Competence (M=21.59). This is quite an interesting result since EMYS was talking significantly more in the High Competence study.

In respect to the amount of time that participants looked at EMYS when it was not talking, there was not a significant interaction. Yet, a significant main effect was found for the Competence level, F(1, 87)=11.585, ρ=.00, showing that participants looked more at EMYS when it was not talking in the Low Competence level (M=16.18) comparing to the High level (M=8.38). This result concerning the competence variable only, shows that participants looked more to EMYS in the Low Competence and even when it was not talking, showing a greater attention than in the High Competence study. This finding may be due to the fact that in this condition EMYS was losing much more games and thus presenting much more negative affect, so people looked more and perhaps experienced more empathy towards the robot.

Participants also talked during the interaction, both with EMYS or to themselves. The amount of time and frequency that participants talked (either to EMYS or themselves) did not present any significant interaction or main effects. Still, it is interesting to note how much participants interacted with the robot verbally even when sometimes they already knew it could not understand what they were saying. In the 91 sessions, participants talked a total of 333 times to EMYS with an average of 5 times per session for the High Competence study and 2 times for the Low Competence study.

6) "Will you let me win this game?": To test if the emotion sharing had any behavioral responses by the users, at the end of the fourth board EMYS asked if the participant would let it win the last board. We wanted to understand if there was an association from participants answers to the condition they were in (Sharing or No Sharing). We performed a Chi-Square Test for Association, but no significant association was found.

In Study 1 (High Competence), the majority of the participants wanted to win EMYS in the last game, but lost (17 for the Sharing Condition and 20 for the No Sharing Condition) this may be explained by the high competence that EMYS shows throughout the game. Only 7 participants chose to let EMYS win the last game and 11 just won the last game.

In Study 2 (Low Competence), the majority of the participants chose to win the game (11 in the Sharing Condition and 15 in the No sharing), also 7 participants chose to let EMYS win the game and 3 lost but wanted to win.

Summing up, it seems participants maintained the competitive posture regardless of the condition. Maybe a similar effect like in[23] could be happening and the competitive nature of the task linked to EMYS asking to win is not seen as "fair" by the participants.

VI. General Discussion and Conclusions

Our main goal was to observe differences in the reported measures regarding the inclusion of the emotional sharing behavior in a competitive scenario, with the hope that by including this behavior, it would create a greater proximity between the robot and the user, making a difference in comparison to when this behavior was not present. In spite of some interesting findings related with the competence of the robot, unfortunately, we did not find many differences between the two conditions (Sharing and No Sharing).

Regarding the affect valence we found that participants perceived more affect in the Sharing Condition, which was somehow expected, but also that more positive affect was present in the High Competence and more negative affect in the Low competence level. According to the number of game wins, this makes sense, since EMYS won more games in the High Competence and lost more in the Low Competence.

The rest of the self-reported measures did not show any significant differences. Through the video analysis, we also found that participants looked much more to EMYS in the Sharing Condition, but since EMYS also talked much more in this condition, we cannot say that the attention given was not a result of that. However, one should notice that participants indeed gave much attention to EMYS (as EMYS could be talking and participants could just ignore the robot, and that did not happen). Also, the Godspeed dimensions did not show differences between conditions.

Finally, even though there was no statistical difference between conditions, it is interesting to note how much participants interacted verbally with EMYS, some did it even after perceiving that EMYS could not understand what they were saying, but they would still respond back to the comments EMYS would do.

Regarding the interaction between competence and the emotional sharing behavior we found some interesting results when taking into account only the Competence variable. Participants reported giving more attention to EMYS in the Lower competence study (and EMYS was significantly speaking more in the High Competence Study), perceiving more negative affect and giving higher scores of Empathic Concern (which assesses other-oriented feelings of sympathy and concern for others). This seems to show that EMYS was seen as more "concerned" by the participants when it was losing more games.

In conclusion, we can reflect on our manipulation and understand that emotional sharing behavior does not seem to have any particular effect in a competitive context. The nature of the task by itself seems to be stronger in setting up the emotional responses of users due to the intrinsic motivation we find in competitive games where just one of them will be the winner. And people want to win and as such, may not be tuned to the emotional responses of the opponent. Also, most of our sample was male, which could be influencing the results, due to a possible gender effect towards self-disclosure[24]. Which we should take into account in future studies.

However, we still believe that emotional sharing can bring closeness in human relationships and maybe even in human-robot interactions. Yet, one needs to take into account other variables that may influence it (e.g. a collaborative context and gender) in order to have an effect. When competing with someone, emotions are important to give feedback on the other intentions and emotional state but they are not enough to call for more prosocial behaviors.

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