SARA: Social Affective Relational Agent: A Study on the Role of Empathy in Artificial Social Agents

Sandra Gama, Gabriel Barata, Daniel Gonçalves, Rui Prada, and Ana Paiva

INESC-ID and Instituto Superior Técnico, Technical University of Lisbon, Av. Rovisco Pais, 49, 1050-001 Lisboa, Portugal
{sandra.gama,gabriel.barata}@ist.utl.pt
{daniel.goncalves,rui.prada,ana.paiva}@inesc-id.pt

Abstract. Over the last decade extensive research has been conducted in the area of conversational agents focusing in many different aspects of these agents. In this research, and aiming at building agents that maintain a social connection with users, empathy has been one of those areas, as it plays a leading role in the establishment of social relationships. In this paper we present a relationship model of empathy that takes advantage of Social Penetration Theory's concepts for relationship building. This model has been implemented into an agent that attempts to establish a relationship with the user, expressing empathy both verbally and visually. The visual expression of empathy consists of facial expression and physical proximity representation. The user tests performed showed that while users were able to develop a simple relationship with the agents, they however developed stronger relationships with a version of the agent that is most visually expressive and takes advantage of the proximity element, confirming the significance of our model based on social penetration theory may have and, consequently, the importance of the visual representation of empathic responses.

Keywords: Affective computing, empathic agent, conversational agent, social penetration.

1 Introduction

Empathy plays an important role in the creation of relationships among people and even other species. As such, if we aim at establishing rich relationships with conversational agents we must address that issue. In fact, providing conversational agents with empathic behaviours has proven not only to increase their believability but also enhance their capabilities in building social-emotional relationships with users. It has been shown in [3] that the implementation of empathy in virtual agents enhances cooperation in different contexts, such as counseling and helping, as well as for educational purposes.

But, capturing empathic processes in conversational artificial agents should go beyond the spoken or written dialogues, by taking advantages of other interaction

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modalities, such as visual, facial and body expressions. Furthermore, empathy is mediated by many factors, such as similarity, personality or even physical proximity. As such, models of empathy for conversational agents need to take into account some of these factors in order to make the interaction richer and more meaningful.

In that context, we have designed and empathic agent that expresses both emotions and closeness by the use of facial expressions and face proximity, respectively. It also expresses empathy through verbal dialogue. The model takes into account the Social Penetration Theory [1] when building a social relationship between the agent and the user. The main goal of this investigation was to study the role of the visual expression of empathy in the development of a relationship between the user and a conversational agent. So, our research question focuses on how two factors: physical proximity and emotional expressions, impact in the perception of the empathic behaviour of the agent.

With the developed system we have performed a limited set of user tests in order to understand the impact that the visual expression of empathy has in the creation a relationship between the agent and the user. Furthermore, the user tests were designed to find out the degree of importance of these features by comparing the results of different variations of the agent in which either visual expressions of empathy was fully depicted, only facial expression was shown, only closeness was represented or neither visual empathic cues were present. The tests used a standard friendship questionnaire, and the results showed that the presence of the visual elements has a positive impact in some elements found in friendship relations.

This paper is organized as follows. In Section 2 we present some relevant related work that situates our approach in the context of empathic agents. We then present the proposed model and briefly describe the interaction between the user and an agent which implements this model. Finally, we present and discuss the results of user tests that we performed in order to find out the role of the visual representation of empathy in the development of a relationship.

2 Related Work

Conversation plays a leading role in the interaction between users and synthetic characters [6]. As a result, several research studies have been conducted in order to create affective agents that can build relationships with users [2].

In particular, relevant work has been done in the context of the COMPANIONS project [7] [9] [15], in which two virtual companions have been created. The Health and Fitness Companion (HFC) acts as a conversational partner whose overall aim is to build a long-term relationship with the user. Planning the day becomes a compromise between the user and the system. A relationship between the agent and the user is built through dialogue. However, the character acts more as a companion than a personal trainer, since it takes a persistent role in the user's daily life. The second companion agent developed in this project was the Senior Companion (SC), which allows elder people to annotate photographs

in order to build up a narrative of their life. Users are allowed to show a friend (the virtual companion) images of their family and friends and the companion prompts users to describe their photos and through conversation the user reminisces about life memories. The information goes through a natural language processing module and is associated with the photographs as annotations. The agent performs face recognition and learns about the user's life, constructing knowledge from it, which contributes to the development of a close relationship.

Another system where the relation between the agent and the user is explored is MAY [6], a conversational companion that implements memory mechanisms in order to create proximity with the user. It is targeted for teenagers and has been created to assist them on self-reflection. The interaction consists of text-based dialogue, and the agent is described as an affective diary, since it reflects the users shared emotional experiences in a timeline form.

Another very interesting agent developed by Bickmore and Picard was LAURA [4], which was integrated on an application (MIT FitTrack) that aimed to motivate users to do physical exercise. The embodied agent supports multiple interactions, contributing to a persistent construction of a relationship. LAURA remembers things about the user's life and refers back to previous interactions. The system's interaction consists entirely of relationship-building dialogue, in which the user selects one of multiple-choice inputs, which are dynamically adapted during each turn of the conversation, while LAURA speaks using synthesized speech. This choice from a set of options can be quite restrictive, because the user is limited to them. In face to face interaction, the emotional display is very important and LAURA has a wide set of non-verbal behaviours associated with the verbal communication, in particular hand gestures, gazing, raising/lowering eyebrows, head nods and walking on and off the screen. These behaviours are automatically generated at compile time. The relational model used in FitTrack considers that initial relations are distant and professional, but gradually become more personal over time. That approach enables a continuous change of behaviour to correspond to user expectations. The user-agent relationship consists of using the relational behaviour, particularly empathy.

More recently, Bickmore et al. [5] have created another agent, Louise, who followed two different approaches to study whether empathic accuracy and user expressivity lead to increasing user-agent social bonds. In the empathic approach, the user is restricted to the way he can express himself, while in the expressive approach users can freely express their feelings conducting to imperfect empathic responses. They concluded that an agent with empathic accuracy is more effective in comforting users, even if their way of expression is restricted.

Bickmore and Picard [4] state that maintaining relationships involves managing expectations, attitudes and intentions. Relationships are supported by emotional interaction and, as such, emotional aspects need to be carefully considered in a companion.

All those systems explore in some way the relation between the user and the agent, exploring somehow the development of more personal relations. Yet none

of them adopts any model of social penetration nor explores how such model can be conveyed and perceived by users, which is what we have done.

3 A Model for Empathy Regarding Social Penetration

Our computational model follows a perception-action paradigm and is inspired by the work of Rodrigues et al. [13], which regards empathy as a process, being grounded in the Perception Action Model (PAM) [11] and Vignemont and Singer's research [16]. Our approach consists of the articulation between this model and the Social Penetration Theory [1], which regulates the gradual development of social relationships. According to the Social Penetration Theory, a relationship can go through four stages: (i) Orientation stage; (ii) Exploratory Affective Stage; (iii) Affective Stage; (iv) Stable stage, as depicted in Figure 1. We have adopted this theory to regulate the expression of empathy with the user: it is not until the third stage is achieved that the model allows the agent to perform certain empathic actions, such as comforting and reassuring.

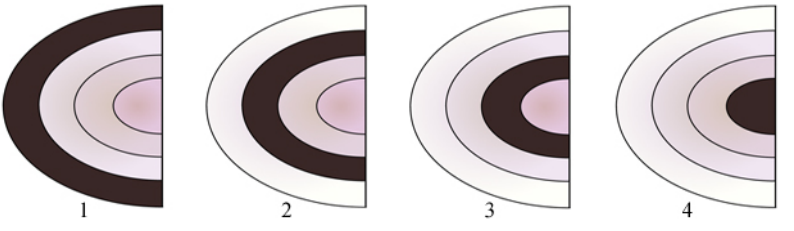

Fig. 1. Social Penetration Theory Stages: (1) Orientation Stage; (2) Exploratory Affective Stage; (3) Affective Stage; (4) Stable Stage

As illustrated in Figure 2, emotion recognition is performed, followed by the generation of an empathic response, depending on the social contextualization of the relationship, congruent with the aforementioned theories. However, while Vignemont and Singer [16] propose several modulation factors, determined by appraisal processes, we perform a social evaluation (based on the Social Penetration Theory) in the two main phases of our model: Empathic Appraisal and Empathic Response.

3.1 Empathic Appraisal

Accordingly with Bickmore et al. [2], even when the user's way of expression is restricted, the agent may be very efficient in comforting users. We have taken advantage of this result by providing the user with four different dialogue options, ranging from uninvolved to warmer responses. Empathic appraisal begins when one option is selected, meaning that the user provided a verbal interaction. This interaction is analyzed through self-projected reasoning, resulting in a potential state of emotion that the agent believes the user to be in. The space

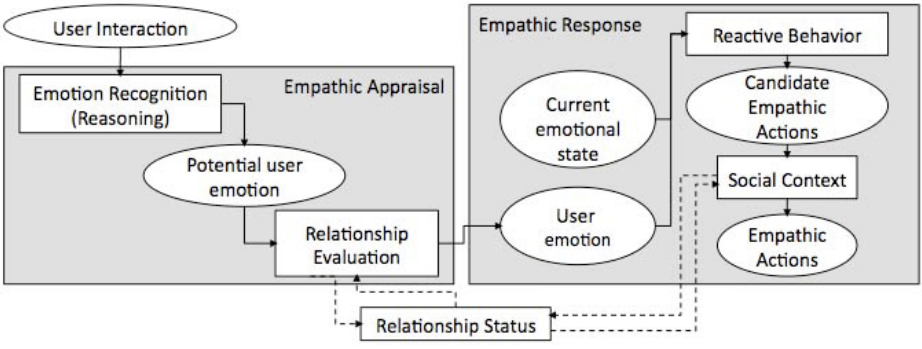

Fig. 2. Model Diagram

of emotions is the same as the agent's: happy, sad, disgusted, angry, surprised, scared, neutral and very happy. The potential user emotion then goes through a social evaluation, which determines whether this emotion is appropriate or not, regarding the relationship's current state of social penetration. As such, the result of Empathic Appraisal is the user's current emotion taking into account both reasoning and social context. For instance, an emotion of strong happiness is more likely to be consistent with more intimate states.

3.2 Empathic Response

The user emotion resulting from Empathic Appraisal is subject to a reactive behaviour which also takes into account the agent's current affective state. Here, potential empathic actions are generated, determing which responses are appropriate given the emotional state of both the agent and the user. However, it is the relationship's intimacy status that determines which actions are most appropriate. As such, a new social evaluation is performed on these candidates, determining the final empathic actions. For instance, when the user's emotion is sadness and the social evaluation allows more intimate actions, not only a close-framed sad face is depicted, but also a verbal comforting emotional reaction is triggered.

Both social evaluation modules perform different tasks - while both are based on the social context, the one on the Empathic Appraisal phase evaluates the user's emotion and the social contextualization on the Empathic Response phase decides which empathic actions are appropriate.

Since relationships are fundamentally social and emotional [2] and people respond to social cues from a computer in the same way that they respond to these cues from other people (even if automatically and unconsciously) [12], one of the most important features of our model is the expression of emotions. In fact, affect leverages the mechanisms of human social cognition, helping to build relationships more naturally [2].

The visual representation of empathy is represented under the form of facial expressions and physical proximity.

Facial Expressions are a powerful way to convey affect [8]. We modelled Ekman and Friessen's [8] six *basic* facial expressions into our agent model: happiness, sadness, surprise, anger, disgust and fear, besides the neutral expression and an expression of increased happiness, as depicted in Fig. 3.

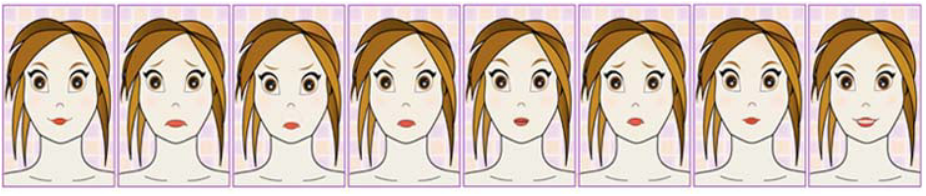

Fig. 3. Facial Expressions (Left to right: happy, sad, disgusted, angry, surprised, scared, neutral and very happy)

Physical Proximity is represented in order to create the feeling of proximity, similarly to Klein et al. [10], who have demonstrated that the use of different proximity frames increases the closeness felt by the user. Furthermore, Bickmore and Picard's research [2] uses 4 conversational frames, with different objectives: a task frame, for task-oriented purposes, a social frame, an empathetic frame and an encouragement frame. We use three different proximity frames (Fig. 4), articulated with the Social Penetration Theory's relationship layers. On less intimate states, the agent is farther, being its body fully shown. As intimacy increases, the face and upper body area are zoomed in. As for more intimate stages, only the face is shown, conveying familiarity.

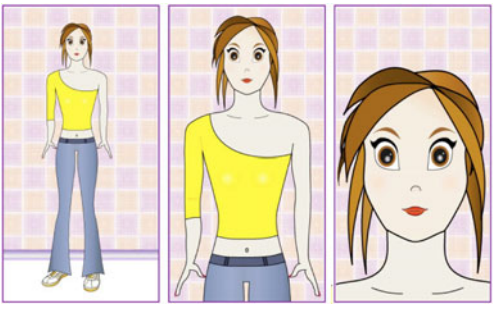

Fig. 4. Physical Proximity

3.3 User-Agent Interaction

We have implemented an agent that follows our model, capable of interacting through dialogue. At each interaction, the agent recognizes the user's state of emotion through reasoning and social evaluation, The user's emotional state and the current social intimacy status of the relationship are used to generate an empathic response, which is expressed both verbally and visually.

Empathic Actions Example Scenario: Let us consider that the agent and the user have been interacting so that the current social stage is at its innermost, which means that the social evaluation allows the expression of warmer empathic responses and proximity is represented at its maximum. Also, the agent is at a current emotional state of happiness. Regarding the current user-agent intimacy, the agent may ask the user 'Are you alright?'. If the user replies 'I'm not so great today', then the resulting agent's empathic action consists of comforting the user. As such, it shows surprise and replies 'Okay. You know you can trust me if you need to talk about your problems, right?'. This example is illustrated in Fig. 5.

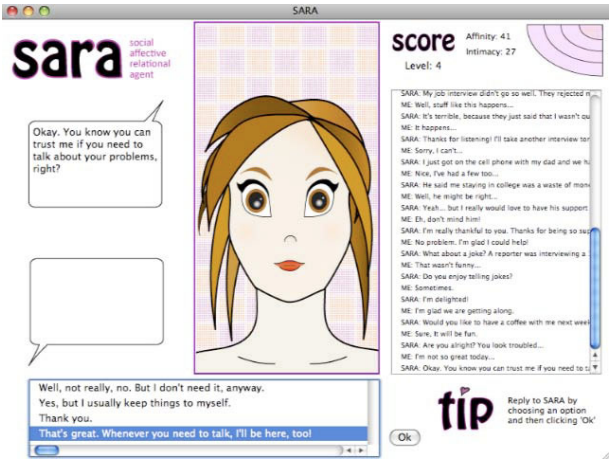

Fig. 5. Empathic Actions Example Scenario

4 Evaluation

In order to test the agent's model, in particular, the Social Penetration Theory's role in the agen'ts capacity to establish a relationship, with focus on the influence of the visual representation of empathy, we performed several user tests.

4.1 Test Scenarios

Given that we have two types of variables to consider (facial expression and proximity), we took into account these two variables and created four versions of the system: **(NP,NE)**: No Proximity, No Expression (control): Both the agent's facial expression and proximity remained constant. The agent was represented both physically distant from the user and showing a neutral facial expression, being thus empathy shown only verbally; **(NP,E)**: No Proximity, Expression: The agent was always represented in the most distant frame but its facial expressions varied. **(P,NE)**: Proximity, No Expression: In this case, proximity frames were used, while facial expressions were not. **(P,E)**: Proximity, Expression: Both proximity frames and facial expressions were used, taking advantage of both forms of visually representing empathy.

4.2 Design and Procedure

Given that the objective was to study the development of social relationships, being friendship a particular type of such relationships, we used an adapted version of the McGill Friendship Questionnaire [14]. The test protocol consisted of a brief presentation of the agent, then allowing users to freely interact with it for at least 10 minutes. Finally, users were asked to fill in a questionnaire, which consisted of a brief set of user profiling questions, followed by the McGill Questionnaire. Since four different control conditions regarding the empathic behaviour have been taken into account, we asked 60 subjects to participate in these tests, 15 per each one of the agent's version, allocated randomly to one of the four conditions. Participants were university students, of different courses and universities, who aged between 18 and 30 years old, of which 52% were female and 48% were male.

4.3 Results

Regarding the visual expression of empathy in the development of a relationship, the general results are depicted in Fig. 6, both for Friendship Functions and Affection. In fact, the combination of facial expressions and physical proximity seems to have a positive impact in building a relationship of friendship, in contrast with the representation of a single visual modality or none. Each part of the questionnaire (Friendship Functions and Affection) was subject to these tests separately.

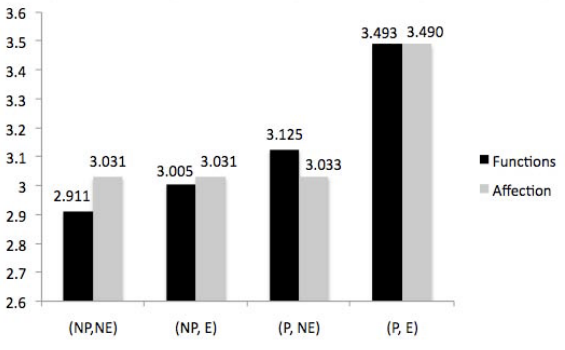

Fig. 6. Average Global Results: Friendship Functions and Affection

A Lilleford Test showed some of the data was non-normal. In fact, for the sets corresponding to the Friendship Functions questionaire, we found no evidence against normality in the second ($L = 0.167, p > 0.1$) and fourth ($L = 0.157, p > 0.1$) sets, yet found evidence against it in the first ($L = 0.204, p < 0.1$) and third sets ($L = 0.229, p < 0.05$). Regarding the Affection questionnaire, we found evidence against normality in the first set ($L = 0.208, p < 0.1$) and signigicant evidence against it in the fourth set ($L = 0.322, p < 0.01$), and no evidence in either the second ($L = 0.118, p > 0.1$) or in the third ($L = 0.143, p > 0.1$).

The fact that some of the data is non-normal suggested the adequateness of a Kruskall-Wallis test to undestand the impact of the visual representation of empathy. We were able to verify that it actually affects significantly Friendship Functions ($H = 10.7, p = 0.0135$), while it also plays an important role in the development of Affection ($H = 6.34, p = 0.0962$).

In order to better understand the impact of the different conditions (combinations of the visual representation of empathy), we performed two sets of Mann-Whitney tests with Bonferroni correction. Each set consisted of the comparrison between each condition (**(NP,E)**, **(P,NE)** and **(P,E)**) and the control group **(NP, NE)**.

Table 1. Mann-Whitney Test Results for Friendship Functions and Affection

Friendship Functions	**(NP,E)** ($Mdn = 2.967$)	**(P,NE)** ($Mdn = 2.900$)	**(P,E)** ($Mdn = 3.367$)
(NP,NE) ($Mdn = 2.700$)	$U = 133.5$ $p = 0.09885$	$U = 147.0$ $p = 0.03965$	$U = 176.5$ $p = 0.00215$
User-Agent Affection	**(NP,E)** ($Mdn = 2.9375$)	**(P,NE)** ($Mdn = 2.9375$)	**(P,E)** ($Mdn = 3.375$)
(NP,NE) ($Mdn = 2.875$)	$U = 115.5$ $p = 0.2301$	$U = 120.5$ $p = 0.18915$	$U = 158.0$ $p = 0.01535$

Concerning Friendship Functions, results have shown that, regarding both Friendship Functions and Affection, **(NP,NE)** does not differ significantly from either **(NP,E)** or **(P,NE)**, while it significantly differs from**(P,E)**.

These results prove the empiric results we had obtained, confirming that the impact of the representation of both facial expression and physical proximity is significant when compared to the presence of only one condition or none of these conditions.

5 Conclusions and Future Work

We have created a model of empathy and implemented it into an agent that expresses empathy through written dialogue and visual cues. One of our main goals was to study and validate the role of the visual expression of empathy in a single interaction with an empathic agent exploring two factors: facial expressions and physical proximity as ways to convey higher states of social affinity.

Evaluation results are encouraging, showing that the visual representation of empathy plays an important role in the creation of a friendship relationship with an artificial agent. It would be interesting, however, to test the model with different agents in order to ascertain whether the agent's appearance has an impact on the results.

Since we have taken into account a single interaction between the user and the agent, it would be interesting to explore the creation and development of a relationship for a series of interactions over time. Being closer to the type of relationships between humans, it would allow us to study the impact of our model in a mid or long-term relationship with a virtual agent.

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