Incorporating Communicative Patterns into Ebdi Agents

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Abstract: This work proposes the use of the well-known Satir communicative patterns in Emotional Belief-Desires-Intentions frameworks (EBDIs) aimed to support the management of Embodied Conversational Agents (ECAs). It shows how to include Satir's model into the ABC-EBDI framework. The framework is based on the ABC psychological model and considers, not only the behavioural and emotional consequences of events, but also the underlying beliefs. This has made possible the connection with the Satir model that specifies facial and body expressions, voice intonation and linguistic structures related to five universal communication patterns. The consideration of the communication styles makes it possible to link the expressive capabilities of the agents with the BDI cognitive processing and to manage them an integrated way.

1 INTRODUCTION

Nowadays, one of the main objectives of AI is the modelling of intelligent agents that reproduce realistic human behavior. To develop these agents, structures are needed that are capable of being flexible and able to cope with the multiple and simultaneous demands of the internal and external environment. Among the most well-known, the BDI (Rao and Georgeff, 1995) cognitive framework stands out. The BDI framework is very popular due to its simplicity and robustness for implementing intelligent agents. It is based on three fundamental mental attitudes: beliefs (that represent information about the environment and oneself), desires (that represent the motivational state of the agent) and intentions (that represent the selected action plans that the agent is committed to achieve and that give the deliberative character to the model). Nowadays, the focus is being put in the modeling of emotions and their influence on the cognitive process, pursuing a more credible and humanlike behavior. Emotional BDIs (EBDIs) go in that direction. In the last years EBDIs have emerged that consider not only emotions but other aspects: some works integrate emotions with mood (Hernández et al., 2004), with personality (Puica and Florea, 2013) or combine the three of them (De Rosis et al., 2003), (Neto and da Silva, 2012), (Alfonso et al., 2014) (Sánchez-López et al, 2019). A complete state of the art on EBDIs can be found in (Sánchez-López and Cerezo, 2019).

Some EBDIs (Bevacqua et al., 2010), (Ochs et al., 2010) and (Becker-Asano and Wachsmuth, 2008), have been applied to the management of ECAs (Embodied Conversational Agents). ECAs are characters usually with human-line appearances endured with the use of natural language and non-verbal behaviors (Cassell, 2000). ECAs can be found in many applications: in medical domains (Bickmore et al., 2016), in virtual storytelling (Gris et al., 2016) and role-playing (Emonts et al., 2012), as interviewers (Nunamaker Jr. et al., 2011), etc. In (Bevacqua et al., 2010) an interactive storyteller is presented. In this case, according to its emotional or mental state, the agent may vary the quality of its behaviors: it may use more or less extended gestures, the arms can move at different speeds and with different acceleration. In (Ochs et al., 2010), the

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application is a 3D talking head that shows facial expressions according to the intensity of the elicited emotions, in order to empathize with the user. In (Becker-Asano and Wachsmuth, 2008) a virtual human named Max, who plays the role of museum guide, is developed. Max is capable of showing facial expressions and body gestures, according to its cognitive reasoning capabilities and emotional state. In these and all other applications the goal is to achieve credible humanlike behaviors. To do so the consideration not only of cognitive but affective capabilities is a must, but also a proper use of agent's embodiment and expressive channels. And the question of how to connect the agent affective-cognitive process with its expressive channels (facial expressions, gaze, body postures and speech) is still an open question.

In this paper, we propose to stablish this connection through the use of a well-known psychological communication model: the Satir model (Andreas & Satir, 1991). The model specifies five universal communication patterns, each of them with their particular expressions in terms of facial expressions, body gestures, voice intonation and linguistic structures. Satir also specifies the type of thoughts that emerge in each pattern. In fact, these patterns are not determined by the personality but directly related to the thoughts that emerge during interaction. These thoughts can be linked to agent's beliefs, making it possible to consider communication patterns into EBDI frameworks.

The aim of this paper is to propose the consideration of communicative patterns in EBDI agents and to show its inclusion in an existing EBDI framework. The inclusion is based on:

1- Widening the concept of the behavioural consequences of events considering not only agent's intentions but their expression.

2- Establishing the link between the intentions and their expression through the processing of agent's beliefs.

3- Managing the expression of the intentions in a coordinated way through the use of Satir communicative patterns.

Satir's patterns have been incorporated into the ABC-EBDI framework (Sanchez et al., 2020), one of the more advanced EBDIs that considers emotions, mood and personality, and their influence in all the cognitive processing stages. The framework is the result of applying a psychotherapeutic model, the Ellis's ABC model (Ellis, 1994) intensively used in the therapeutic ambit, to the EBDI scheme. The selection of the ABC model is because it allows modeling not only emotions and actions in adverse situations but the underlying human beliefs that conditions human's thoughts.

The remainder of the paper is organized as follows. In section 2 the Satir communication model is presented. In section 3, the integration of the Satir communication model into the ABC-EBDI is presented. In section 4, the ECA application being developed is shown and, finally, conclusions are presented.

2 SATIR COMMUNICATION PATTERNS

The Satir model (Andreas & Satir, 1991) is a very well-known psychological model extensively used in family/couple therapy but also applied in different fields (Health, Education, Engineering, etc.). The model proposes a graphic representation of the behavior patterns that manifest themselves in situations of personal conflict, in a way that is easily observable and still applied (Peters & Das, 2021).

Observing people while communicating, Satir discovered five universal patterns of communication: Placating, Blaming, Computing, Distracting, and Leveling (see Figure 1). These styles are ways of communicating and every person has those he/she uses more frequently. But it is dynamic: in the real word individuals move between the communication styles rapidly and frequently: a person can be leveling at one moment, and then blaming in a rapid sequence depending on how she/he is coping with her/his internal process.

Satir also noticed that there were three parts of communication in every transaction, they are: 1. self, 2. other, and 3. context. She noticed that in the first four, Placating, Blaming, Computing and Distracting, the three components of self, other, and context are out of balance. One or two of the components are considered of higher value than the other or are excluded. In the fifth communication style, Leveling, all three -self, other, and context- have equal value and are in equal balance.

The first four styles are adopted in stress situations involving the self-esteem. In those situations, most of the people adopt one of these four communication styles to hide their feelings:

- Placating: apologetic, eager to please (hides fear). The person gives the other person higher value than they do to themselves: self is devaluated over the other and the context. Expressions such as "Please do not

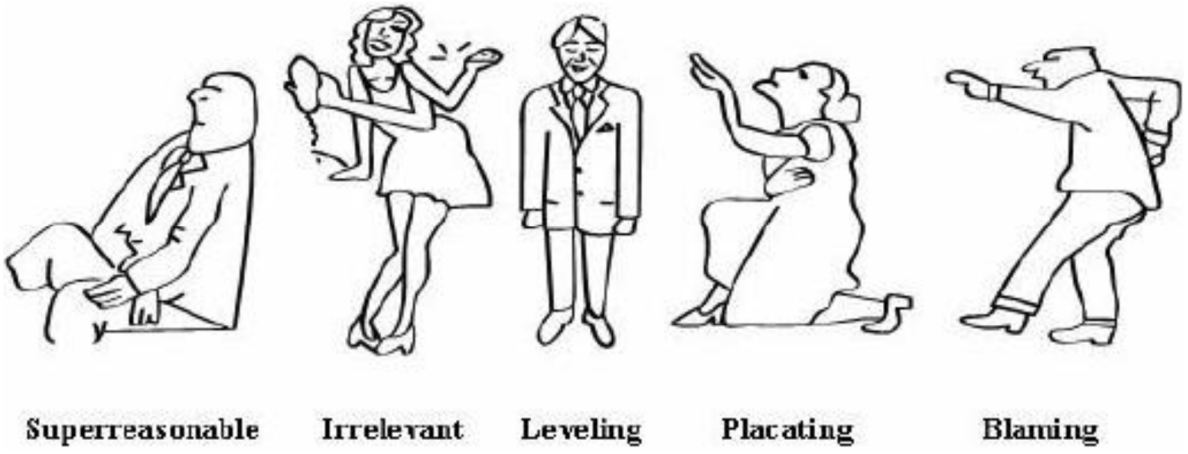

Figure 1: Satir's patterns: Superreasonable, Irrelevant, Leveling, Placating and Blaming. Adapted from (Andreas & Satir, 1991).

shout on me", "I will do anything you ask" are used. Placating searches for other's love and acceptance.

- Blaming: fault-finding, critical (hides pain). What the person wants is more important than what the other person wants and the situation they are in. Expressions such as "If it weren't for you, I would not be so angry." "It's your fault I hit you. If you had not provoked me, you would not have gotten hit." Blamers give the other person responsibility for their feelings and life. They tend towards arguments, threats and physical violence towards other.
- Superreasonable: computing, abstract (afraid of feelings). The person shows no emotions or affect. They tend to have tense body posture and their responses are intellectual, authoritative, and reasonable and come as a lecture to the other person. Examples of expressions are: "I am calm, cool, and collected", "A true man never expresses his feelings or anger, hurt, disappointment", etc.
- Irrelevant: irrelevant, talkative (afraid of reality). The words do not make sense, the person talks about something else, changes the subject, and makes inappropriate jokes. The individual does not connect to the context and reality or the other people. He or she excludes the self, the other and the context. Their basic message is: I do not matter, you do not matter, and the situation does not matter. When asked a question they often do not answer it directly and may respond with an irrelevant comment.

The fifth pattern, Leveling, is very different and distinct from the four other communication styles. Leveling considers the self, other people and the context in communications and recognizes each part as having equal value. The person is aware of his or her physiological and bodily responses and shares thoughts and feelings.

For each pattern the model defines several communication characteristics that allow the individual's behaviour to be personalized. Each pattern defines the body posture, facial expression, voice and linguistic structure as shown in Table 1 and Table 2.

Satir also goes into the detail of the type of thoughts that emerge in each pattern:

- Placating: "I feel like nothing, I'm dead without him. I'm worth nothing".
- Blaming: "I am lonely and unsuccessful".
- Irrelevant: "Nobody understands me, I do not belong anywhere".
- Superreasonable: "I feel easily at people's mercy".

Thoughts related to the Leveling pattern are objective and positive, always oriented towards achieving the objectives, to flexibility and openness to change. The individual enjoys the freedom to be himself/herself and to accept and to love others.

These thoughts are the way of linking both models, Satir and ABC-EBDI framework, as it is explained next section.

Table 1: Body gestures and facial expressions of Satir communication patterns.

Pattern	Body posture	Facial expression
Blaming	Pointing with a finger. Tense, distorted, flat, compressed breath	Tense facial muscles, pursed lips, expand nasal passages, annoyed look
Placating	Body in low position, as kneeling begging, and saying yes to everything. Slumped, swaying, head turned upwards, hand held forward pleadingly	Sad facial gesture, look to the floor
Superreasonable	Straight body posture, feeling of tranquility and control. Unanimated, stiff, non-reactive	Does not finch, does not show emotions, direct gaze
Irrelevant	The body goes in different directions (uncoordinated movements), joining the knees in an exaggerated manner, bending the shoulders.	Distracted, lazy, entertaining, distracted gaze
Leveling	Freedom of movement	Neutral expression, look into the eyes

Table 2: Voice and linguistic structures of Satir communication patterns.

Pattern	Voice	Linguistic structures
Blaming	Scream with a hard voice, tense, shrill	Universal quantifiers: all, everyone, never, everything, always, every time. Assumed causal relationships (if, then: because) Use of negative questions: Why not do it?
Placating	Nasal voice, with complacent tone, whining, squeaky, pressed	Use of restrictions: if, only, even, at all. Use of many subjunctives: could, would, might, should, etc.
Superreasonable	Monotonous and dry	Omission of nominative arguments. Use the longest possible words, even if not sure of the meanings. Deletion of reference indices. Use of nominalizations. Use of nouns without reference indices: it, one, people etc. Deletion of the subject / subject reference.
Irrelevant	Singsong that clashes with words, erratic, fast, animated	Arbitrary use of all three language patterns, missing references and links, rapid change of the other patterns. Words without meaning and irrelevant
Leveling	Warm	Direct answer

3 INTEGRATION OF THE SATIR MODEL INTO THE ABC-EBDI

To explain the integration, first an overview of the ABC-EBDI framework is presented.

3.1 ABC-EBDI Overview

The ABC-EBDI framework (Sanchez et al., 2020), based on Ellis's ABC model (Ellis, 1994) focuses in the modelling on how an individual feels, what he/she thinks and his/her conduct in adverse situations. In the ABC-EBDI framework, components and processes have been defined that allow affect (emotions, mood, personality) and behavioural modelling to be integrated in the logical reasoning process of BDI agents. Its main cognitive management components are:

- Beliefs system (B): this comprises what the agent believes about an event, the information about himself and the environment, and the reactive behavior of the agent. The system starts from three sets: basic beliefs (B_0) (general information of the

agent about itself and the environment), context beliefs (B_c) (cognitions about an activating event) and those that represent operant behaviors (Bop).

- Desires (D): These represent the motivational state of the agent. The system starts from two sets of desires: basic desires (D_0): to be happy, not to die and not to suffer, and context desires (D_c).
- Conduct (C): This is defined as the behavioral consequences following the ABC model. It comprises intentions and how they are performed. The consideration, not only of the intentions but, of the way of expressing them opens the door to the management of the agent's expressions (facial expressions, body gestures, intonation …). Here we propose to handle these expressions in a coordinated way by mean of the Satir model.

The general cognitive/affective process is as follows (see Figure 2): When an event (A) occurs, the agent perceives (perceive) the environment or its internal state, and perceptions about A arise. Later on, beliefs are reviewed (***blf_revision***). Depending on the activating event type, three types of beliefs about A can be obtained: operant behaviors (B_{op}), basic beliefs (B_0) and context beliefs (B_c). If beliefs related to operant behaviors arise, the cognitive process directly filters (***filter***) the agent intentions and selects (***select***), conduct to finally execute the action (***action***).

If Context beliefs (B_c) arise they are processed (***brf_processing***) and classified as irrational/rational beliefs ($B_{I/R}$).

After the beliefs revision process, irrational/rational desires ($D_{I/R}$) are obtained (***options***). In this stage the event is also evaluated to know if it is motivationally relevant (according to the desires) and will therefore elicit emotions: if there is high motivational relevance the agent will "feel" emotions and the emotional generation process (affective management) starts. If desires are irrational dysfunctional emotions will arise; rational desires will lead to functional ones. Eight dysfunctional/functional negative emotions (anger/annoyance, guilt/remorse, anxiety/concern and depression/sadness) and three positive emotions (gratitude, happiness and pride) are modeled. The Besides, the agent mood (M) is updated according to the elicited emotions. Afterwards, conducts (C) are selected (***select***). The process is influenced by the irrational/rational character of desires and the dysfunctional/functional nature of emotions: if

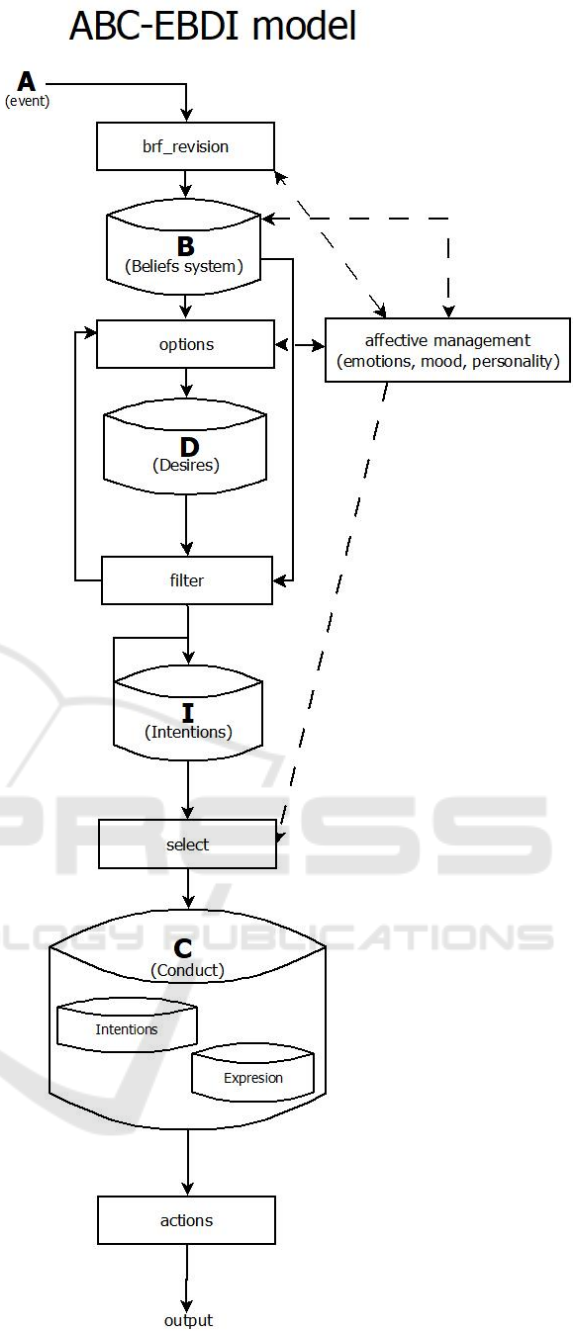

Figure 2: A general overview of the ABC-EBDI framework.

desires are irrational (D_I) and emotions are dysfunctional, the conducts will be maladaptive (C_M) and, on the contrary, if desires are irrational (D_R) and emotions are functional, the conduct will be adaptive (C_A). As stated before, the agent's conduct comprises the intentions to achieve the irrational/rational desires and how the agent will express them. Finally, conducts are executed (***action***).

During the cognitive-affective process, when Context beliefs arise, they are identified as one of Ellis irrational or rational beliefs and further classified following the classification:

1- Irrational beliefs classification:

- Demandingness (DEM): There are three types:
  - Demands for Comfort (DEM comfort): those related to comfort and equity/rights.
  - Self-related demands of achievement and competence (DEM achievement/ competence): those related to oneself, one's achievements and personal competence.
  - Demands for control (DEM control): those related to rigid and dominant conduct.
- Awfulizing (AWF): A catastrophic evaluation, the worst that can happen.
- Global evaluation-self or other-downing (GE/SD): An excessively global negative evaluation about himself, others or the world in general.
- Low frustration tolerance (LFT): If an individual tolerates a situation according to the nature of his or her formulated desires.

2- Rational beliefs:

- Preferences: These refer to preferentially desiring something and they are expressed in the form of "I want" and "I wish".
- Non-awfulizing (non-AWF): This refers to a flexible negative evaluation done by an individual for not having satisfied his or her preferences.
- Unconditional acceptance (non-GE/SD): This is the antidote to the irrational belief/global/critical evaluation (GE/SD).
- High frustration tolerance (non-LFT): This refers to the tolerance capacity of an individual when preferences are not met.

In Table 3, examples of thoughts related to each category are presented. In Table 4 the Ellis' General Irrational and Rational Beliefs (first column) and their categorization (second column) are shown.

Table 3: Example of thoughts related to Irrational/Rational beliefs categorization.

Irrational/Rational Category	**Examples of thoughts**
DEM comfort	I am worried that with this hanging over me, my family might not love me anymore
DEM achievement/competence	I cannot afford to be weak in this situation
DEM control	I have cancer because of the kind of life that circumstances force me to live".
AWF	I cannot do anything; this is only the beginning of the end
GE/SD	Maybe, because of this, they will stop loving me and I couldn't stand it.
LFT	I don't feel able to face this by myself. I will put myself in their hands."
Preferences	I wish I had no cancer
non-AWF	I want to concentrate on what I have to do now
non-GE/SD	Life does not always turn out as one would wish
non-LFT	I am the one who decides what is the best for me and I know all the possibilities

The agent conduct is determined by the irrational/rational cognitive-affective processing that results in a maladaptive or adaptive behaviour. More detailed description of the framework can be found in (Sanchez et al., 2020).

Table 4: Mapping between Irrational/Rational beliefs (first column) and Satir's patterns (third column) by means of the Beliefs categorization (second column). Example thoughts related to Satir's patterns are also shown.

General Irrational beliefs (IB)	**Category**	**Satir's Pattern**
IB-I - It is an extreme need, for the adult human being, to be loved and approved by every significant person in his environment.	DEM comfort Global evaluation/self or other-downing (GE/SD)	Placating - I'm dead without him/ No one will accept me.
IB-II - To consider myself as a valid person, I must be very competent, sufficient and able to achieve anything that I propose.	DEM achievement and competence Global evaluation/self or other-downing (GE/SD)	Blaming - I am unsuccessful/I am unable to do anything right.
IB-III - People who do not act as "should" are vile, evil and infamous and should be punished for their evil.	DEM control Global evaluation/self or other-downing (GE/SD)	Superreasonable- I feel easily at people's mercy.
IB-IV - It is terrible and catastrophic that things do not work out as one would like.	DEM achievement and competence Awfulizing (AWF)	Blaming- I am lonely and unsuccessful.
IB-V - Human disgrace and discomfort are brought about by external circumstances, and people have no ability to control their emotions.	DEM control Global evaluation/self or other-downing (GE/SD)	Superreasonable- I feel easily at people's mercy.
IB-VI - If something is or can be dangerous, I must be terribly worried about it and I must constantly think about the possibility of it happening.	DEM comfort Awfulizing (AWF)	Placating- I feel like nothing.
IB-VII - It is easier to avoid the responsibilities and difficulties of life than to confront them.	DEM comfort Low frustration tolerance (LFT)	Irrelevant- Nobody understands me, I do not belong anywhere.
IB-VIII - I must depend on others and need someone stronger to trust.	DEM comfort Low frustration tolerance (LFT)	Placating - I feel like nothing.
IB-IX - What happened to me will always continue affecting me.	DEM comfort Global evaluation/self or other-downing (GE/SD)	Placating- I'm worth nothing/I will never be fine.
IB-X - We must be very concerned about the problems and disturbances of others.	DEM comfort Global evaluation/self or other-downing (GE/SD)	Placating – I am alone/No one love me.
IB-XI - There is a perfect solution to every problem and if we do not find it, it would be catastrophic.	DEM achievement and competence Secondary - Awfulizing (AWF)	Blaming – It's my fault/ There is no solution, it's all over.
General rational beliefs (RB)	**Category**	**Satir's pattern**
RB-I - I accept my own limitations and mistakes, and my behavior is not conditioned by the continuous search for recognition and approval of others.	Preferences Unconditional acceptance (non-GE/SD)	Leveling – I am strong and confident in myself.
RB-II - Each person has the right to act according to his or her criteria, without me having to expect them to behave according to what I expect, need, or consider right.	Preferences High frustration tolerance (non-LFT)	
RBIII - Life and its circumstances happen in an independent way to my needs and it is me who must adapt to manage the possibilities and difficulties that arise.	Preferences Non-awfulizing (non-AWF)	

Figure 3: Moving from a console-based output (left) to an ECA-based application (right).

3.2 Integration

The Satir model goes into the detail of the type of thoughts that emerge in each pattern and illustrates that individuals can respond to stressful experiences in both adaptive and maladaptive ways (Thompson et al., 2010). Thoughts related to the four patterns linked to stress and tension are based on irrational beliefs (related to dysfunctional emotions and maladaptive behaviours) and in the case of the Levelling pattern, they are based on rational beliefs and therefore, linked to functional emotions and adaptive behaviours.

In the ABC-EBDI when Context beliefs arise, they are identified as one of Ellis irrational or rational beliefs and further classified following the classification explained before. As Satir describes the thoughts linked to each of the patterns, two of the authors (psychologists) have proposed a link between the general irrational beliefs and the first four communication patterns through the categorization of the general irrational beliefs shown in the second column in Table 4. As it can be seen, all rational beliefs are linked to the Leveling pattern.

In the first implementation of the ABC-EBDI just text output is considered. A use case consisting of a bad news scenario in healthcare domain was simulated (Sanchez et al., 2020). The simulation reproduces the dialog between the doctor (user) and the patient (agent). In each step, during the dialog the system inputs are the doctor entries and the outputs are the following:

1. What the agent thinks: Characterization of the irrational/rational beliefs about the event (cognitive information).
2. What the agent feels: Emotions and current mood (affective information).
3. How the agent behaves: Agent answer and conduct.

An ECA-based application is being developed to make profit of the new conduct information: the communicative pattern activated. In the ECA-based application the chat-based interface is substituted by an ECA (Embodied Conversational Agent) interface (see Figure. 3). The ECA interface is being implemented in Unity 3D and communicates with the simulation engine through sockets.

To render the appropriated agent expression, the value of the emotions elicited and the communication patterns activated have to be combined to produce a credible animation. For the moment emotions elicited during the simulation condition facial expressions and voice intonation whereas communicative patterns modulate body gestures. To do so animations for each of the five Satir's patterns have been developed as well facial animations corresponding to each of the emotions considered (some of them shown in Figure 3).

4 CONCLUSIONS

EBDI frameworks are now capable of managing the cognitive and affective consequences of events on agents. Some of them are being used to support the management of embodied agents able to express themselves through facial, body gestures and voice. How to link this expression with the cognitive affective management of the agent is still an open question.

In this paper we propose to make this link through the use of Satir's model, a well-known psychological model that establishes five general communicative patterns. We have shown its integration into an advanced EBDI framework, the ABD-EBDI known by its sophisticated management of agent's beliefs. An ECA based application is being developed and will make it possible to compare simulation results with previous console-based application to assess the impact of the new expression channels.

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