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Culture–personality based affective model

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Abstract Bringing culture and personality in a combination with emotions requires bringing three different theories together. In this paper, we discuss an approach for combining Hofstede's cultural dimensions, BIG five personality parameters and PSI theory of emotions to come up with an emergent affective character model.

1 Introduction

Culture is an important part of the expression and communication of human feelings (Brislin 1993). It influences the way every event and object is viewed and the same objects or events can have different conceptions based on the cultural norms and variables. In order to develop affective smart environments which respond to the individual, it is useful to understand and model their culture. To do this, we are developing agent models which can embody different aspects of culturally influenced personality.

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To define cultural differences in agents, we have to define certain variables which describe the cultural personality in an agent. There have been definitions of cultural variability by social psychologists such as Hofstede and Hall (Dörner et al. 2006; Dörner and Starker 2004), and these form the basis for our model. We aim to model characters which are able to display cultural properties based on these models research.

Culture impacts on many aspects of human behaviour. However, this research focuses on intercultural communication, i.e. communication between characters belonging to different cultures.

In order to make agents (representing different cultures) interact, it is necessary to define cultural parameters and formalise how the agent's actions should depend on these parameters. Particular parameter settings then provide a simple way of defining different cultural stereotypes (while recognising that an individual's parameters will often differ from the stereotype).

In this paper, we explain how can the culture and personality can be combined to be used in an emergent affective architecture.

2 Background

Culture plays a significant part in communal communication as humans are differentiated on the basis of cultures. Culture can be defined as "the forms of things that people have in mind, their models for perceiving, relating or otherwise interpreting them" (Hofstede and Hofstede 2005). People interact with each other using cultural properties which existed historically in the geographical group they belong to (Kluckhohn and Kelly 1945).

(Keesing 1974) defined culture as:

Culture, conceived as a system of competence shared in its broad design and deeper principles, and varying between individuals in its specificities, is then not all of what an individual knows and thinks and feels about this world. It is his theory of what his fellows know, believe, and mean, his theory of the code followed, the game being played, in the society into which he was born… (p. 89).

According to Hofstede and Hofstede (2005), culture is the collective programming of the mind that separates one group of people from another. Examples of culture include language, technology, economic, political and educational systems, religious and aesthetic patterns, and social structures (Trandis 1990). The mental programming model presented by Hofstede (Fig. 1) illustrates the relationship of culture with personality and human nature.

2.1 Cultural differences

Cultures have a big role in shaping the behaviours and personality of an individual. These personalities in fact have some similarities which makes them a part of a social group. The properties of one social group differ from others. Sometimes the differences are very subtle and sometimes they are totally reciprocal.

It will be worth looking at some of the studies and theories about these socio-cultural differences as these become the basis of this research on modelling cultural agents. Certainly, the way these groups show similarities and differences in displaying and recognising emotions is really interesting.

Ishii et al. (2003) used an interference task to test the hypothesis that people in different cultures are differentially attuned to verbal content vis-à-vis vocal tone in comprehending emotional words.

In Study 1, Americans showed a greater difficulty in ignoring verbal content (which reveals an attention bias for verbal content); Japanese showed a greater difficulty in ignoring vocal tone (which reveals a bias for vocal tone).
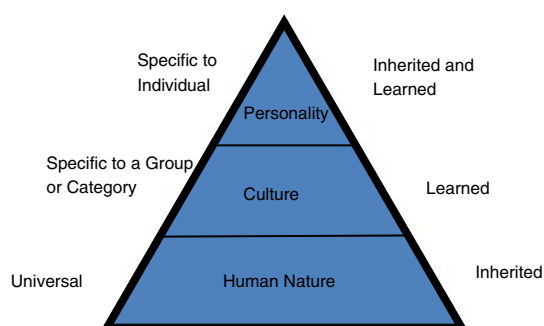

Fig. 1 Three levels of uniqueness in mental programming (Hofstede and Hofstede 2005)

In Study 2, Tagalong-English bilingual in the Philippines showed an attention bias for vocal tone regardless of the languages used, suggesting that the effect is largely cultural rather than linguistic.

People modify their expressions on the basis of cultural display rules, (Brislin 1993) these are culturally agreed rules, learned early in life and they force the management and alteration of the universal expressions depending on the social situation.

Culture has some influence over the way people express and perceive emotions, the research in this field is quite active but not a lot of studies have been published, some of the results are very interesting and challenging.

Most of the studies in this regard try to find the differences and similarities in both the expression and perception of emotions in different cultures.

The difference and some similarities are present in humans of all ages in spontaneous emotional expression.

1. Camras et al. 1998 examined spontaneously occurring expressions in infants of 11 months from three different cultures: China, Japan and European Americans and indicated that Chinese babies were less expressive than the other two. It has been noted that the reaction of the infants was based on the behaviour of the mother who certainly was influenced by some of the cultural properties.

2. Waxer 1985 examined facial expressions in Americans and Canadian game show contestants. He found no difference in types of emotions but found some differences in way of expressions like the American females were found to use their hands more than Canadians and the American males smiled more than Canadians did. This shows that even cultures which are quite close geographically can have some very subtle differences.

3. Ekman (1972) demonstrated the existence of these rules by conducting a study of watching stressful films alone and in the presence of an experimenter. Matsumoto (1986) extended the original Ekman experiment by using collectivistic and individualistic encoders. They found out that the collectivistic people showed less negative expressions in the presence of an experimenter. This also gives a direction that normally collectivistic societies have to maintain face in a group to make the group relations stronger.

Education, social standing, religion, personality, belief structure, past experience, affection shown in the home and other factors will affect human behaviour and culture (Ratner 2000).

- In México it is customary for the *arriving* person to greet the others. For instance, someone who walks into

a group of persons eating would say *provecho* (enjoy your meal).

- In Chile, women often greet both other women and men with a kiss on the cheek.
- In Russia women often walk arm in arm with their female friends.

Paying attention to customs and cultural differences can give someone outside that culture a better chance of acceptance. Ignoring these can get an unsuspecting person into trouble.

There are differences in approach as to what is considered polite and appropriate behaviour both on and off the job.

In some cultures "yes" means, "I hear you" more than "I agree." Length of pleasantries and greetings before getting down to business; level of tolerance for being around someone speaking a foreign (not-understood) language; politeness measured in terms of etiquette (for example., standing up for a woman who approaches a table, yielding a seat on the bus to an older person, etc.); and manner of expected dress are all examples of possible cultural differences and tradition.

2.2 Cultural variability models

Cultural dimension models seek to measure different cultures on a number of cultural variables or factors. Here, we discuss how Hofstede has categorised the cultural variability into four dimensions:

2.2.1 Hofstede's dimensions of cultural variability

Hofstede (1972) proposed a four factor cultural model, which is perhaps the most cited in cross-cultural communication papers. These dimensions provide a useful basis for defining culture in terms of individual and collective behaviour. Each of these dimensions refers to variability to the behaviour and communication between people.

2.2.1.1 Individualism and collectivism Individualism collectivism is one of the most important cultural dimension which affects behaviour at both cultural and individual level.

Individualistic cultures emphasize personal rights and responsibilities, privacy, voicing one's own opinions, freedom, and self expression. The "I" identity places emphasis on individuals with less concern for the group. Reciprocity is voluntary, self-initiated or self-motivated. A personal bonus or incentive is seen as helping to motivate the individual toward achieving the goals of the group. Focus is on the management of individuals rather than the management of the group (Berger and Calabrese 1975).

Collectivistic cultures emphasize community, collaboration, shared interests, harmony, traditions and public good. This culture can suppress emotions according to the mood of the collection (Triandis 1994). Body movements and other kinesics are more synchronised. The "we" identity takes major prominence. Attention is on what will benefit the group. There is a sharper distinction between an in-group and out-group. It takes longer to gain admission to the in-group (Hofstede 1990). Feeling is one of the mutual obligations which is more long term and can stretch over years. Members feel interconnected in a group orientation system which creates more group solidarity. Management can appeal to this group-level solidarity. Seventy-five percent of the world's population subscribes to some kind of collective outlook and approach.

This parameter, and others, may impact on the individual agent's psychological needs. In this case, for example, it will influence the need for affiliation. This provides a link from the general cultural stereotype to the intentions and behaviours of the individual agent.

2.2.1.2 Uncertainty avoidance In some cultures freedom produces uncertainty, which leads to stress and anxiety. These cultures may seek to avoid uncertainty by increasing rules of behaviour. Berger and Calabrese (1975) suggests that many southern European countries, as well as Japan and Peru, tend towards uncertainty avoidance. Other countries (including many northern European countries) are, it is argued, better able to tolerate freedom and diversity without excess stress and anxiety (Ratner 2000). A culture's rigidity and dogmatism are a function of the uncertainty avoiding dimension. This dimension also influences communication between individuals; particular direct or indirect forms of communication can be used to reduce uncertainty.

"What is different is dangerous."

In some cultures freedom produces uncertainty, which leads to stress and anxiety. These cultures may seek to avoid uncertainty by increasing rules of behaviour. These countries include: Greece, Portugal, Belgium, Japan, Peru, France, Chile, Spain and Argentina (Berger and Calabrese 1975).

"What is difference is curious"

Other countries are better able to tolerate freedom and diversity without excess stress and anxiety. These countries include: Singapore, Denmark, Sweden, Hong Kong, Ireland, England, India, etc. (Gudykunst and Mody 2002). Culture's rigidity and dogmatism are a function of the uncertainty avoiding dimension. It also includes uncertainty avoidance communication between individual according to culture and describe the different types of direct or indirect approaches to avoid or get rid of uncertainty.

2.2.1.3 Power distance This influences the way people from different cultures communicate with other people with different power distance and standing in the society or organisation.

Members of high power distance cultures see power as a basic fact in society. Authority comes from position. "If I'm the boss, treat me like the boss." Direction is expected. "Since you are the boss, you tell me what to do." Formality is emphasized and practiced. Communication is in a downward vertical direction, for example, South Asia, Caribbean, France, etc. (Hofstede 1972). On the other hand, members of low power distance cultures view that power should be used only when it is legitimate, for example, European countries which are normally middle class democracies located at high latitudes, people feel equal. Interaction is informal and at a horizontal level. People expect to be consulted, to be part of the decision-making process.

This dictates the way people from different cultures communicate with other people with different power distance and standing in the society or organisation.

2.2.1.4 Masculinity–femininity This dimension can be defined by the degree to which a society focuses on assertiveness, task achievement and acquisition of things as opposed to quality of life. Gender is a big factor in defining rigidity in cultural roles. Members of cultures high in masculinity value performance, ambitions, things, power and assertiveness. Members of cultures high in femininity value quality of life, service and caring for others, e.g. in masculine society students are encouraged to compete and praise the success of the winner.

The countries which Hofstede (1972) found distinctly feminine included Sweden, Norway, Denmark, The Netherlands, Costa Rica, Finland, Yugoslavia, and Chile. Countries that were high in masculinity included Japan, Austria, Venezuela, Mexico, Switzerland, Ireland, Jamaica, Germany and Italy.

2.2.2 Correlation between Hofstede's dimensions

These dimensions correlate on the basis of national culture, e.g. there is a strong correlation between power distance and individualism/collectivism dimensions; the countries that are high on individualism are found to be low on power distance but there can be mild exception. Similarly there is mostly a weak correlation between the Masculinity/ Femininity and Uncertainty avoidance dimensions (Brislin and Yoshida 1994).

2.3 Cultural Profiles

Geert Van Hofstede (Hofstede et al. 2002) used a few techniques in cultural non-computer games for role-plays,

in order to represent culture they came up with some profiles for the cultural dimensions. In our model, we intend to use a similar profile based on different dimensions and combining them together to represent a complex synthetic culture. The requirements for the characters based on the conceptualization would be as follows:

Core value is the value of the extremity of cultural dimensions; *core distinction* is the basic distinction that the members of a particular culture make when observing the social world around them. This helps in perceiving the characters in the world and part of the perception part of the model. *Key behaviour* is a list of golden rules for appropriate behaviour in the culture. This will define a cultural personality depending on norms and behaviours. *Words with a positive connotation* "Words people like to use and like to hear". These will be very important for emotional responses and recognitions. *Words with a negative connotation* "Words people don't like to use and hear".

Apart from them, actions and beliefs make the rest of the profile such as non-verbal behaviour, stereotypes, outsider's evaluation of the culture, gender roles.

2.3.1 Intercultural communication

Intercultural communication can be simply called the communication between people from different cultures (Gudykunst and Mody 2002). Due to differing values and the cultural variability, their perceptions and interpretations of feelings and models in mind are different. With the growth of globalization, the contact and interaction between people from different cultures has increased manifold and consequently the need for a more fruitful intercultural communication has increased.

There can be differences in intercultural communication because of some stereotypes and constraints in cultural norms. The two types of communication verbal and non-verbal express these differences. The verbal communication comprises language and the context involved. The non-verbal communication includes body movements and other gestures which certainly differ in different cultures.

2.3.2 Difference in verbal and non-verbal communication amongst cultures

There is an ancient philosophical difference between eastern and western cultures on rhetoric contents in communication. At roughly the same time when Confucius and Lao Tze preached the futility of verbalization in the east, Socrates, Plato and Aristotle taught the importance of reasoning and logical persuasion on the other side of the world.

The western culture of words and the eastern culture of harmony are well illustrated in their respective explanation of the creation of the universe (Goodenough 1964).

2.3.2.1 Western cultures of words "In the beginning was the word, and the word was with God and the word was God. He was with God, in the beginning through him all things were made; without him nothing was made that has been made" (John 1:1e).

2.3.2.2 Eastern culture of harmony "Tao bears the one (the whole), the one bears the two [Yin (femaleness) and Yang (maleness)], the two bears the three (Yin, Yang and the human), and the three bears the world" (Tao De Jing, p. 42).

In fact these two definitions describe the amount of context and collectivistic and individualistic dimensions of the cultural variability.

Non-verbal factors which differ in different cultures and are also called immediate behaviours are the display properties in cultural communication and will be the basic of the recognition of behaviours in agent system and will serve as the clues for the user to identify the culture and understanding cultural differences as they are much easier to recognise than the verbal content. Non-verbal communication refers to all aspects of message exchange without the use of words. It includes all expressive signs, signals and cues (audio, visual, etc.) apart from manual sign language and speech. Basically the non-verbal cues are categorised into the following gestures (Table 1).

3 Emotional models (PSI model of emotions)

Emotions play a critical role in rational decision-making, perception, human interaction and human intelligence (Picard 1997). The former view of 'emotion as an irrational element that distorts cognition' has been overturned by findings from (e.g. Damasio 1999; Lazarus 2001). Damasio provides neurological support that there is no 'pure reason'

Table 1 Types of non-verbal behaviours

| Behaviour	Explanation
Proxemics	Spatial difference while communicating
Kinesics	Movement of body parts
Haptics	Reaction to touch
Physical appearance	Clothing, skin colour, etc.
Oculesics	Use of eye in communication
Vocalics	Voice animations
Olfactics	Sense of smell

in the healthy human brain but emotions are vital for rational human thinking. Emotions focus our attention acting as evaluation mechanisms on performance, filter relevant data from noisy sources and provide a global management over other cognitive capabilities, important when operating in complex real environments (Oliveira and Sarmento 2003).

Emotions are the source and effect of any human–human interaction. For example, when we are happy, we tend to greet everyone we meet and are more open to ideas. However, if someone returns our greeting with a frown, we might feel insulted. While we are experiencing negative emotions, we are usually more careful and more reluctant to agree to any suggestions. (Picard 1997) argues that 'a machine, even limited to text communication, will be a more effective communicator if given the ability to perceive and express emotions'. An emotionless character is lifeless, a machine. Therefore, emotions are an essential element to create socially rich synthetic characters that will be involved in believable social interactions.

Many emotional models have been proposed and adopted in various affective agent systems. Some examples of non-cognitive architectures are those by Cañamero (1997), Velásquez (1997) and Blumberg (1996). Agents in these architectures perform simple action selection behaviours based on low-level physiological needs such as motivational, neuronal or hormonal mechanisms. On the other hand, agents in systems that employ cognitive architectures such as those proposed by Elliot (1992), Bates (1994) and Gratch and Marsella (2004) perform action selection based on the OCC appraisal model (Ortony et al. 1988) where emotions are viewed as valenced reactions that result from subjective appraisals of events. Since the focus of this research is on culture, we will discuss in detail only the emotional model most relevant to the proposed model.

We view emotions as resulting from the modulation of cognitive processes including perception, motivation, action selection, planning and memory access as proposed by PSI (Dörner 2003). These processes work in concert for effective action regulation allowing the creation of biologically plausible characters. Three successes of the PSI model in replicating human behaviour in complex task can be found in Bartl and Dörner (1998), Dörner et al. (2006) Lim (2007). Within the PSI theory, processes are self-regulatory because all behaviours produced by a character are driven by a limited number of basic needs, including existence preserving need, species-preserving need, affiliation need, certainty need and competence need. Needs emerge over time or as a result of interactions. Deviation from a set point constitutes the strength of each need and a character's aim is to reduce deviation as much as possible (Fig. 2).

Fig. 2 PSI model of emotions
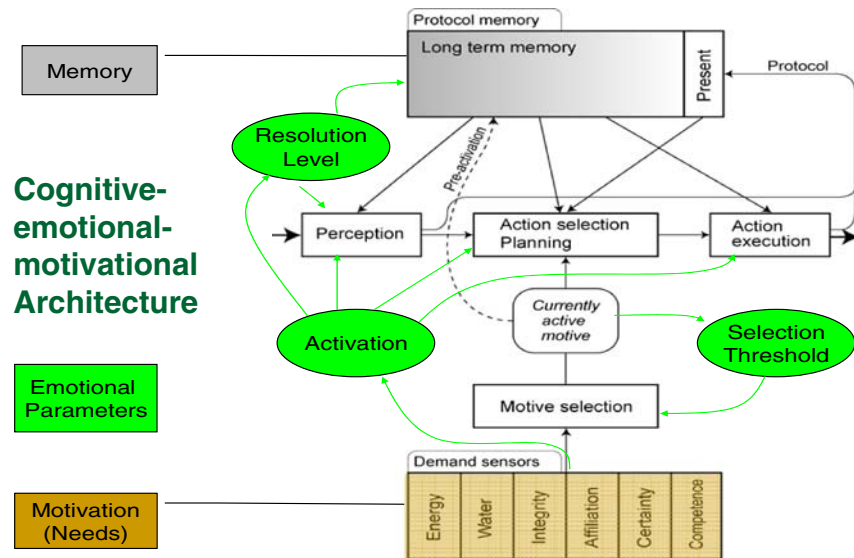
Existence preserving needs are physiological needs like food and water. Species-preserving need ensures reproduction and continuity of a species. The need for affiliation serves as a motivational basis for engaging in social contacts, an important aspect of social communication. Need for certainty models the ability of being able to predict what will happen in a certain situation and being able to predict the consequences of one's own actions. Need for competence measures the ability of being able to master task including the ability to satisfy one's needs. Need for certainty and need for competence are cognitive needs and are of extreme importance to reasoning and learning. Together, competence and certainty direct the agent towards explorative behaviour, depending on its abilities and the difficulty of mastering the environment it will actively seek novelty or avoid complexity.

In addition to needs, a character has a set of modulators that affect cognitive processes: *arousal, resolution level* and *selection threshold*. *Arousal* refers to the character's preparedness for action. This parameter increases with general pressure from the motivational system as well as the strength of currently active intention. An increase in needs will lead to higher *arousal* whereas a decrease in needs will lower *arousal*. *Resolution level* determines the accuracy of cognitive processes such as perception, planning and action regulation. *Selection threshold* prevents oscillation of behaviour by giving the currently active intention priority thus decreasing distraction to the current task. *Resolution level* decreases with heightening *arousal* while *selection threshold* increases with heightening *arousal*.

Different combinations of needs and modulator values result in the subjective experience of emotions. For example, when the environment poses threats, *needs* are high, *arousal* and *selection threshold* will be high and

resolution level will be low. In such a situation, time-consuming search is forbidden since quick reaction is required. The character will concentrate on its current task to fulfil the deviated needs. Due to the lack of deliberateness in processing and fast actions, we might diagnose that the character is experiencing anxiety.

Functionally, a PSI character perceives the environment continuously. It reacts to the environment by forming memories, expectations and immediate evaluations to determine the effect of an event on its needs. It then builds up intentions to satisfy the needs, stored in its memory. Once an intention is selected, three levels of goal-oriented action execution can be distinguished. First, the character tries to recall an automatic, highly ritualised reaction to handle the intention. If this is not possible, a plan may be devised by combining parts of other action sequences. If both fail, it explores the environment to collect more information to generate actions that may contribute to goal satisfaction. By trial and error, it learns about its environment and different options available for needs satisfaction. The choice of strategy for action execution depends on the character's current emotional state. For example, detailed planning or exploration will be performed only if the character's *resolution level* is above a certain threshold, when there is no immediate threat to the character's needs. This usually happens when the character is highly competent and certain about its environment.

Furthermore, a PSI character learns by experience and possesses a memory system in which all perceptions and activities are continuously recorded. This memory may be exposed to decay as well as amplification. The memory traces of the immediate past and those that are concerned with needs satisfaction are very dense and less susceptible to decay. These traces are stored in short-term memory. With continuous activation, this memory may eventually

become long-term memory, whereas other weaker memory chains will be destroyed rather quickly (Bartl and Dörner 1998). Over time, the agent learns about the best ways to satisfy specific needs. The character adapts its behaviour to different environmental circumstances flexibly. The emergence of emotions and behaviour through this adaptation mechanism makes PSI characters more natural and biologically plausible.

For social behaviour, the needs for affiliation, certainty, and competence are of special importance; existence-related needs have to be satisfied for the agent to turn to "social" needs, because of their relative importance for the agent's survival. In a given situation (e.g. a party), the need for affiliation leads to an intention depending on the context, e.g. make a friend and engage in conversation. A moderate to low general estimation of competence and thus a low success probability of the intention means that the agent does not know much about how to satisfy the need for affiliation (due to few or bad experiences at previous parties when it did not succeed in making friends). However, the success probability may be high enough to start some initial trials which may be successful (resulting in talking to someone who might become a friend) and thus present a possibility to escape social isolation. Yet if they are negative and unsuccessful (the agent does not achieve to talk to anyone), it develops more mental representations of unsuccessful social encounters (representing, for example, the awkward situation of standing alone in one corner of the room while all the others have fun at the party).

Thus, the needs for certainty and competence rise as a consequence (meaning that the agent feels uncertain and incompetent), since the agent experiences an ongoing disability to satisfy important needs. This motivational state triggers specific parameter sets, e.g. high arousal and low resolution level which results in inaccurate perception, rough thinking, and nervous behaviour; behavioural tendencies that are generally not supportive for successful social interactions. As still no success is achieved, at some point the need for competence outruns the need for affiliation, the urgency for the enhancement of competence is increased and the current intention is selected accordingly. Hence, the agent withdraws from the social situation (leaves the party) in order to improve its competence and certainty by turning to areas where it knows how to solve problems and satisfy its needs (e.g. reading a book, watching a movie, going for a walk). By this, the agent learns more and more to avoid social interaction: the intention to make friends or to engage in social contacts is stored in long-term memory and connected with low success probability.

Thus, the basic need for affiliation is not satisfied. Representations in memory for social interactions are consequentially connected to indicators for the need of affiliation by aversive relations (resulting in attitudes like "I don't need friends or parties; I'd rather read a book instead…"). Plus, the representations for social interactions stay unrelated to action representations suitable to satisfy affiliation needs ("How can I make friends at a party?"). Continuing failure to satisfy the affiliation needs consolidates these relations in the memory.

3.1 Emotions in PSI and the OCC model of emotions

In PSI, emotions are modelled as emerging from the information processing and not as separate constructs. Behaviour emerges on the basis of needs and perceptions from the environment, and emotions are modelled as modes in which the actions are acted out, as described above. This innovative approach can be compared to models that are widely used to model emotions in the context of artificial intelligence and cognitive modelling, e.g. the OCC model of emotions (Ortony et al. 1988). It is an appraisal theory which means that emotions result from cognitive representations and appraisals of the current situation the organism is dealing with. These appraisals result in emotions and can refer to the outcomes of events, the agency of other agents or the attributes of objects. For each of them the appraisal criterion is different. Objects are appraised regarding their appealingness, agents regarding the praiseworthiness of their actions, and the outcomes (or consequences) of events are appraised regarding their desirability. Ortony et al. (1988) posit that different appraisals lead to qualitatively different types of emotions. In short, advantages of the PSI approach as compared to the OCC model are:

- Emotions need not to be modelled separately but emerge from the system.
- There is no need to define a number of relevant emotions.
- Emotions emerge as a consequence of need states instead of linking them directly to events or actions which makes for more psychological soundness.
- This leads to believable dynamics of emotional states that do not rely on thresholds and decay rates (as in OCC) but on current need states that also determine action selection.
- Arousal is already part of PSI and does not need to be calculated from the general intensity of emotions; rather, activation determines the emotional state (in PSI terms, arousal does not decrease in the absence of intense emotions, but when basic needs are satisfied).

Dörner and Starker (2004) presents a validation that the emotions in PSI agents are very important and also those they improve the problem solving ability. The experiment involved evaluating the PSI model with and without

emotions and came up with the result that emotional modulation based system is more able to adjust with respect to the requirement of the situation as compared to the one with out emotions.

4 Personality: BIG five model

In order to represent individuals belonging to cultures, we use parameterisation of both culture and personality so that they do become part of the overall working of the affective model. The personality does define the top of the personal programming as described earlier in Fig. 1. To include the personality in a parameterised format, we use the BIG five dimensions of personality.

- *Openness to experience* refers to the degree to which one is able to accept unconventional and new ideas;
- *Conscientiousness* is defined by one's self-discipline and dutifulness in performing a task;
- *Extraversion* is being energetic and outgoing, experiencing positive emotions and seeking the company of other people;
- *Agreeableness* determines how compassionate, altruistic and cooperative one is; and
- *Neuroticism* refers to how vulnerable one is towards experiencing negative emotional states (John 1990; McCrae and John 1992; Goldberg 1990).

This model represents higher-order dimensions and offers the possibility to integrate other personality theories. Moreover, questionnaires like the NEO-PI-R (Ostendorf and Angleitner 2004) that are based on the five factor model (FFM), include self-report items that assess personality "sediment" in attitudes, subjective experiences, motivation, and behaviour; hence, it assesses personality in a rich and broad sense. As described above, the basic and theory-independent dimensions are replicated in various cultural contexts, though with slight variance (John and Srivastava 1999; de Raad 2000; Cheung et al. 2001). While there is no indication as to users having specific notions about the personality of virtual agents being fundamentally different from those in humans, it can be assumed that people judge virtual agents with the same categories in mind as they judge other humans.

As we know from previous research regarding the importance of the basic human need for belonging or affiliation (Baumeister and Leary 1995; Dörner 2003) of the research regarding theory of mind processes (see above), we continuously—and more or less consciously—try to comprehend or foresee the reactions of our closest social interaction partners. A widespread heuristic used by people to describe others is the concept of personality, providing labels for cross-situational stable behavioural patterns of behaviour. Therefore, we have formed many words (adjectives) that we use to describe others. These words have been at the centre of one important branch of personality research, a meta-theoretical approach that tries to use these words that people use when they talk about others and their personality to find, by means of statistical data reduction (factor analysis), the basic dimensions that are at the bottom of all personality description. The result of decades of research in different cultures and languages are the so-called "BIG Five" personality dimensions (lexical approach to the study of personality; see e. g. Goldberg 1990; McCrae et al. 1996).

As both the BIG five and the cultural dimensions mentioned earlier are derived by numerical evaluation of questionnaires this makes these theoretical models easier to use in computational synthetic characters. In the next section, we describe how we use these theories in terms of computational values and parameters.

5 The culture–personality based affective model

Now that we have looked at the theories that relate to our approach, in this section we present the model which bring together the culture and personality theory in a parameterised approach. This model is based on the PSI theory of emotions which incorporates culture and emotions its drives and needs. Figure 4 shows the theoretical overview of the model (Fig. 3).

The cognitive processes in a PSI-based model depend on the needs of the character and these needs are the driving force behind intentions, planning and goals and action selection. The different modules of the model can be explained using an example scenario. Figure 4 shows the working of the model; it explains the different modules and flow of information throughout the model. There are needs which generated and select intentions with the help of the emotional modulators. The modulators and the intentions select plans goals of the character; these goals once achieved help satisfy the need.

Culture and personality in this model become the part of the motivation part by defining need thresholds. These thresholds become the basis of the behaviour; secondly the cultural values also become part of the action repertoire part to select cultural actions. For example, suppose we have two characters belonging to two different cultures talking to each other at a work place. The characters have different cultures and personality.

5.1 Character minds

Character mind is stored like the cultural profile discussed in the profiling culture section and basically consists of the
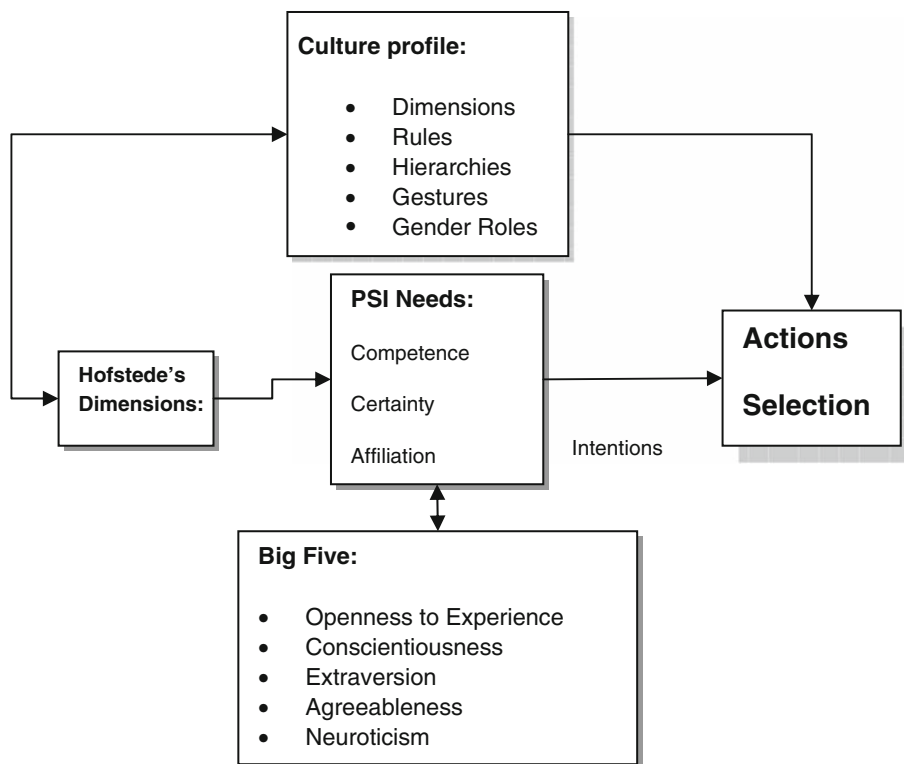
Fig. 3 Theoretical links in the model
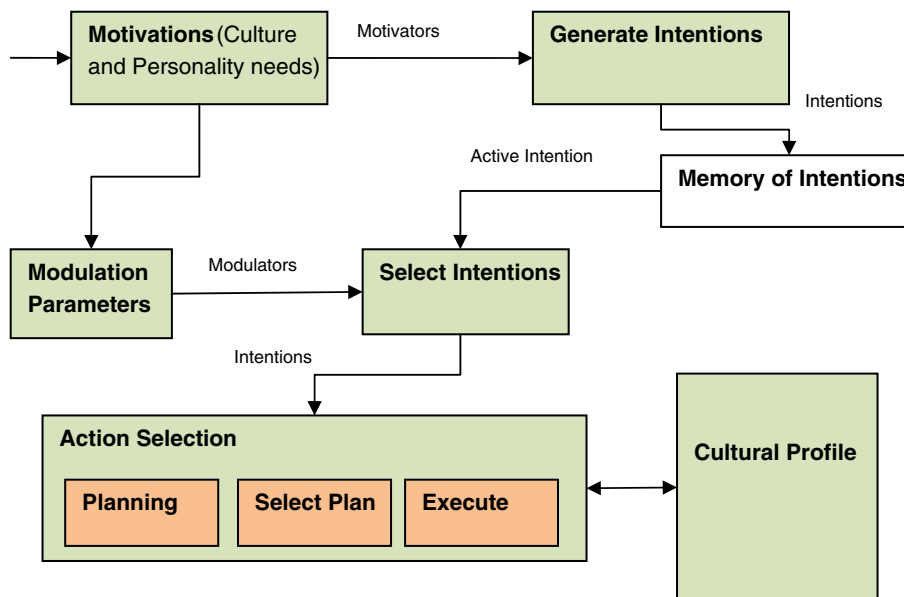

Fig. 4 The culture–personality based affective model

cultural, personality parameters, PSI need thresholds and goals of the characters:

Culture is differentiated on the basis of Hofstede's dimensions and assessed by giving those values to define how intense the reflection of these dimensions on a culture is. In order to use these values in a motivation part of the model, we need to assign values to culture so that they can easily be mapped to the needs values in PSI model which range between 0 and 1.

To implement a complex culture which involves more than one dimension, we have to allot values to every cultural dimension separately to combine them to get the collective value of a culture which is called the core value. This core value will be used to define the possible action a particular character can take.

Let's look at it in terms of values. Suppose we have a character belonging to a highly individualistic, low power distant, feminine culture where the uncertainly avoidance

is very low, and another character which is highly collectivistic belonging to a very high power distant culture where uncertainty avoidance is very low; the following values on a scale of 1–5 for each cultural dimension are given (Table 2).

And similarly we have values for the personality of the two characters in terms of the BIG five personality traits (Table 3).

Now that we have defined the cultures and personality numerically, we have to represent them in the motivational system. In character minds the values will be stored as thresholds.

We can translate the cultural dimensions and personality factors to PSI by using values for each dimension. Values for PSI needs are defined on the scale of 0–1 and to translate the culture values to the PSI need values, we transform them to the scale of 0–1 on the basis of their importance. For example, if a character belongs to highly individualistic culture and has the identity value 4.0, the corresponding PSI value will be 0.8 for competence need as it is more important to the individualistic character so the value would be 0.4 for the affiliation need because it is not very important for the highly individualistic character. When needs have high importance, the value mapping for culture ⇔ PSI is 1.0–5.0 ⇔ 0.2–1.0, whereas when needs have low importance, the reverse mapping applies 1.0–5.0 ⇔ 1.0–0.2.

After mapping the values for the cultural and personality values to the PSI needs, weights to the dimension n according to the real needs are allotted. Table 2 shows the threshold values of the three needs based on the cultural dimension value of the characters. The method is to take the PSI values mapped to the culture values and multiply them to the weight allotted to each dimension (the values in the parenthesis). The weights change according the importance of the need to a particular cultural dimension. As you can observe, not all the cultural dimensions are in each need, this is because of the relevance of the particular dimension to the need. For example, uncertainty avoidance dimension is not relevant to the need for affiliation, etc.

Here, we actually provide the value of thresholds for three needs, i.e. affiliation, certainty and competence and also the rate at which these needs increase. So that when the need reaches a certain level, it has to be satisfied and the arousal level and resolution level will be influenced.

Table 2 Values for cultural dimensions

Cultural DIMENSIONS	Character 1	Character 2
Identity (I)	5	1
Hierarchy (H)	1	4
Gender (G)	2	4
Certainty (C)	4	1

Table 3 Values for personality

Cultural dimensions	Character 1	Character 2
Openness (I)	2.5	5
Conscientiousness (H)	5	2
Extroversion (G)	5	2
Agreeableness (C)	4	1.5

Table 4 Calculation for need importance thresholds

Needs	Character 1	Character 2
Affiliation		
	0.1	0.25
(0.50) I	0.1 (5)	1 (1)
(0.25) H	0.2 (1)	1 (4)
(0.25) G	0.4 (2)	0.6 (4)
Certainty		
	0.325	0.175
(0.25) I	0.2 (4)	0.8 (4)
(0.75) U	0.8 (4)	0.2 (1)
Competence		
	0.25	0.3
(0.50) I	0.8 (4)	0.4 (2)
(0.50) H	0.2 (4)	0.8 (4)

Table 5 Mapping of personality values

Needs	Character 1	Character 2
Affiliation		
	0.425	0.263
(Weight 0.75) E	1.0 (5)	0.4 (2)
(0.25) A	0.4 (4)	0.9 (1.5)
Certainty		
	0.70	0.50
(1/3) A	0.4 (4)	0.9 (1.5)
(1/3) C	1.0 (5)	0.4 (2)
(1/3) O	0.7 (2.5)	0.2 (5)
Competence		
	0.725	0.675
(0.25) E	1.0 (5)	0.4 (2)
(0.25) A	0.4 (4)	0.9 (1.5)
(0.25) C	1.0 (5)	0.4 (2)
(0.25) O	0.5 (2.5)	1.0 (5)

Table 6 Average of culture thresholds and personality thresholds

Needs	Character 1	Character 2
Affiliation	0.263	0.257
Certainty	0.513	0.338
Competence	0.488	0.488

These needs can also be increased in the reaction to an event (Tables 4, 5).

And finally, we come up with the combined value (Table 6) of the thresholds for culture and personality.

<Goals>

<Goal name="GreetAccept([target])" importanceOfSucess="6" importanceOfFailure="2" need="Affiliation"/>

</Goals>

Intention generation and selection will occur on the basis of the level of need or motivation, the perception of

<Action name="Greet" Goal = "GreetAccept">

<action_performed = "handshake" culture_value_min = 10 culture_value_valuemax = 15>

<action_performed = "wave" culture_value_min = 15 culture_value_valuemax = 20>

<action_performed = "wave" culture_value_min = 15 culture_value_valuemax = 20>

</Action>

the environment and goal of the agents. Intentions will be selected from a memory of intentions where different intentions are stored. According to Dörner (Brislin 1993) the intentions are calculated with the following formula:

$$S_i = \sum (\text{Needs} \times \text{Satpot}_{goal}) \times \text{SP} \times \text{Urgency}$$

In this case the relevant need will be the level of affiliation or certainty required. SP is the success probability of achieving a goal. Calculation of success and urgency depend on:

- Perception of actual situation;
- Expectation of upcoming events;
- Experiences regarding goal-related action.

Goals of the characters depend on the scenario and are stored in the character mind; the goals are connected to a sequence of actions to achieve them. The goals are stored in the mind with relation to the needs they satisfy, so that upon achieving these goals the value for the need is lowered.

Goals are linked to set of actions which are necessary to achieve the goal, actions are listed according to the cultural intensity to categorise them into cultural actions: For example, the greeting action is always a highly cultural action and is unique for each culture.

5.1.1 Actions

The actions in the model depend both on cultures and emotions and they are implemented to achieve the goals

which in turn satisfy the needs so the goals are represented in the following way which also indicates a particular goal actually satisfies which need

The actions are represented as having the following attributes:

So now according to the culture value or the cultural intensity the action gets selected, an action or a sequence of actions is performed to achieve a goal, achieving that goal lead to satisfying the associated need.

The action selection part will depend on the planner and appraisal method, and for this the double appraisal method is intended to be used.

PSI needs become the basis of behaviour. The production of actions depend on the intentions which are generated to make a link between needs that drive the agent and the goals it has to achieve to satisfy them. Intentions consist of goals of the character and needs that are to be satisfied by those goals and action sequences to achieve that goal.

Once the model is loaded, the intentions based on the needs are selected; beginning of the intention selected is of greeting the other characters in the world. In the example the two characters start by greeting themselves.

The actions are selected according to cultural value which defines the values for the proxemics, kinesics, oculesics, etc. These actions depend on the value of the culture as described in Table 2, because the value of these parameters changes according to the change in the intensity of culture.

These modulations are realised by so-called emotional parameters. Different combinations of parameter values result in the subjective experience of emotions. It involves three emotional parameters: activation, resolution level and selection threshold.

- **Activation**, which is the preparedness for perception and reaction on side of the agent; this parameter increases because of the motivations and active intention values. The concept of activation is similar to the psychological concept of "arousal".
- *Resolution level* It decreases with an increase in activation it determines the accuracy of cognitive processes, e.g. perception, planning, action regulation
- *Selection threshold* Prevents the currently active intention to be replaced by another, equally strong intention. It gives priority to current intention. Concentration of the agent depends on this parameter.

Once an intention is selected the set of actions related to the intentions are performed and consequently the goal is achieved. Action selection depends on the selected intention and the planning execute a sequence of action. To test this, we have implemented a small scenario and the sample out put is as follows:

World
Bill enters the room
Chan enters the room
Bill says Hello!
Bill greets ()
Chan says Hi
Bill says Its a nice day
Chan says yes
Bill says I hear your wife is pregnant
Chan says She is fine
Chan greets
Bill greets

Character 1: Bill	Character 2: Chan
Bill dimensions Identity = 5,	Chan dimensions Identity = 1,
Hierarchy = 1	Hierarchy = 4
Gender = 2	Gender = 4
Certainty = 4	Certainty = 1
Bill personality openness = 1	Chan personality openness = 5
Conscientiousness = 4	Conscientiousness = 2
Extroversion = 4	Extroversion = 2
Agreeableness = 1	Agreeableness = 1.5
Bill need thresholds Affiliation = 0.263	Chan need thresholds Affiliation = 0.257
Competence = 0.513	Competence = 0.338
Certainty = 0.488	Certainty = 0.488
Adding new intention: GREETING()	Selecting new intention: GREETINGACCEPT()

continued

Character 1: Bill	Character 2: Chan
Goal Success: greet(): Character 1 Emotions value = 0.5 needs affiliation = 0.283 competence = 0.2 certainty = 0.1	Goal Success: greet(): Character 2 Emotions value = 0.5 needs affiliation = 0.2 competence = 0.2 certainty = 0.1
Selecting new intention: CHANGE_TOPIC()	Selecting new intention: REPLY()
Goal Success: know about(): Character 1 Emotions value = 0.6 needs affiliation = 0.2 Competence = 0.3 certainty = 0.4	Goal Success: know_about(): Character 2 Emotions value = 0.6 needs affiliation = 0.1 Competence = 0.4 certainty = 0.1 RED FLAG RAISED
Selecting new intention: CHANGE_TOPIC()	Selecting new intention: END_CONVERSATION()
Goal Success: GreetAccept(): Character 1 Emotions value = 0.6 needs affiliation = 0.2 Competence = 0.3 certainty = 0.4	Goal Success: Greet(): Character 2 Emotions value = 0.1 needs affiliation = 0.2 Competence = 0.3 certainty = 0.4

This example shows the process of selecting intentions and goals satisfied and also the emotional parameters at every point. The emotional value is the combination of emotional parameters and describes the current state of the character in the range of 0 to 1. The red flag is raised when some event happens that is culturally a critical incidence and makes the character very emotional and is considered as a breakdown in the communication.

6 Conclusion

In this paper, we have presented a model for synthetic characters which incorporates theories from social and behavioural psychology. We describe in this model how these theories can be combined to form a computational model for affective synthetic characters. We argue that synthetic characters should be able to represent culture and potentially be able to embody different cultural personalities. When we talk about affective architectures, we think that culture and personality adds to the believability of the characters and also affects the way the world is perceived by the characters. Culture is not only represented by the gestures and apparent physical or verbal actions but it becomes a part of the internal programming of the agent mind and its motivations to take actions which achieve goals for the character.

We also describe a prototype implementation of the model with a small scenario which demonstrates working proof of concept. The model is still in the implementation phase and we are in the process of improving the complexities of scenarios and relationships amongst different

perimeters of the model. After the implementation an evaluation will be planned to check the effectiveness of the approach and to prove the hypothesis that synthetic character can simulate culture and personality by being emergent in their responses and emotions.

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