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Handbook of Research on Culturally-Aware Information Technology:
Perspectives and Models

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Chapter 18
Towards Culturally-Aware Virtual Agent Systems

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ABSTRACT

Globalization leads to an increase in intercultural encounters with a risk of misunderstandings due to different patterns of behavior and understanding. Learning applications have been proposed that employ virtual agents as their primary tool. Through their embodiment, learning can be done in a game-like environment in a more interesting way than for example learning with a textbook. The authors support the idea that virtual agents are a great opportunity for teaching cultural awareness. Realizing this, the concept of culture needs to be translated into computational models and the advantages of different systems using virtual agents need to be considered. Therefore, the authors reflect in this chapter on how virtual agents can help to learn about culture, scan definitions of culture from the social sciences, give an overview on how multiagent systems developed over time and classify the state of the art that integrates culture in multiagent systems. In addition, an approach of simulating culture-specific behavior using such a multiagent system is introduced and future trends in enculturating virtual agent systems are outlined.

INTRODUCTION

In the not so distant past, everyday conversations were generally held between people from the same geographical region who shared a common ground in social norms and expectations. Experiencing different cultures was only possible for a very small group of people that ventured out into the unknown, often ill-prepared with knowledge about other cultures. Due to globalization, a larger group of people is able to get in touch with other cultures nowadays. Through modern communication devices such as the Internet or teleconferencing systems, communication across different cultures is possible, even without traveling. As a result, communication is much easier on the one hand, but

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on the other, miscommunication comes into play. Large geographical distances, different upbringing and education evoke a lack of common ground in social knowledge, which cannot be taken as granted any more. In (Hofstede, 1991), the patterns of thinking that drive an individual are described as the "software of the mind" that is a product of the social environment that one grew up in and one's own life experience. Besides globalization, immigration leads to an increased contact to people with different cultural backgrounds (Ting-Toomey, 1999). Thus, different cultural believes, values and communication styles meet each other in one and the same country. Language as main medium of communication is the most obvious barrier of intercultural communication. But even when communication partners speak the same language, misunderstandings can arise through cultural differences, such as differences in nonverbal behavior or different perceptions of behaviors.

Moreover these misunderstanding are often not recognized as such. If communication partners e.g. take for granted a common ground of social knowledge, they might interpret each other's behaviors in their own culture-specific way. Assuming that this interpretation is correct, behaviors might be decoded wrongly but stay unrecognized. Even worse than being overlooked, the interlocutor might assume that the behavioral misconduct was done on purpose and thus, one could be offended. In this way, people might be confronted with being refused without knowing the reason for it, which in turn can lead to frustration.

Following Hofstede (1991), the authors state that being aware of the fact that some behaviors are interpreted differently across cultures is the first step to avoid inter-cultural misunderstandings and with it, to learn intercultural communication.

In (Hofstede, 1991), the acquisition of inter-cultural communication abilities is explained in three steps:

(1) **Awareness:** The first step of gaining intercultural competence is being aware of culture-related differences in behavior. The most noticeable part of this step is not only to know about differences, but to accept the fact that there is no better or worse way of interacting - that it is just different. Consequently, individuals need to learn that one's own behavior routines are not superior to others.

(2) **Knowledge:** Gaining knowledge is the next logical step. This implies learning about the target culture's symbols and rituals. This does not necessarily include that one shares the values of a culture, but at least has an idea on where these values differ from one's owns.

(3) **Skills:** Hofstede states that the steps of Awareness and Knowledge are sufficient to avoid most of the obvious misunderstandings in cross-cultural communication. The third step of gaining skills in intercultural communication however needs more practice. This includes recognizing the symbols and heroes of the other culture and practicing their rituals.

The authors think that multiagent systems are a powerful medium in gaining intercultural competencies and that they can be used in all three learning steps described above in the following way:

(1) **Awareness:** The first step on the way to inter-cultural understanding can be simply achieved by observing virtual agents that show a certain culture-specific behavior. A trainee can for example be confronted with a group of characters without any prior information about the culture he or she is interacting with.

(2) **Knowledge:** Gaining knowledge about another culture can be done by observing virtual agents, too. However, additional information

is required about the behavioral differences shown in the scenario. Explanations about the culture-specific behaviors can be given either before observing them or afterwards as a debriefing.

(3) **Skills:** In order to practice certain behavior routines, a simple observation is not enough. For the third step of gaining intercultural competences the learner needs to be integrated into the virtual scenario and thus, be able to interact with virtual agents that represent another culture. Through their reaction and behavioral suggestions, learning can be done in an interactive way in a game-like environment.

Using virtual agents instead of human training partners has several advantages, as the authors pointed out in (Rehm et al., 2007b). First, with a virtual agent as communication partner, the task can be repeated as often as liked, without the risk of annoying a human training partner or paying for each additional lesson. Another advantage is that an emotional distance is kept. On the one hand, the trainee might feel embarrassed by training behavior routines with a real human and on the other hand, he or she does not need to be afraid of embarrassing the virtual agent by treating it in a culturally inappropriate way. In addition, cultural differences in behavior are often very subtle and thus, hard to recognize. Using virtual agents, these differences can be acted out in an exaggerated manner or can be shown in isolation. In contrast to real humans, virtual agents can change their culture. In that way, one and the same agent can simulate the behaviors of different cultures and point out the differences.

With the concept of using virtual agents in order to create cultural awareness, the authors aim on preventing trainees from judging others without being aware of the fact that behavioral differences might be aroused by culture. However, to achieve this goal a closer look at culture and its definitions in the social sciences has to be done. Secondary, systems using virtual agents need to be reflected as well as their evolution over time in order to classify how culture has been integrated into multiagent systems so far. In the following sections, a deeper insight into the theoretical background on culture and virtual agent systems is given, as well as a reflection on the state of the art in enculturated virtual agents. The authors then introduce their approach of integrating culture-related differences in behavior into a multiagent system. Thereby, the focus is on the behavioral aspect of interpersonal communication management, which controls the flow of a conversation.

CULTURE IN THE SOCIAL SCIENCES

As stated earlier, the objective of this work is to build a multiagent system that serves as a training environment, where the style of communication varies with culture. Thus, first culture and especially cultural differences need to be defined and how they manifest themselves. Definitions of culture in the social sciences are rather abstract and conceptually describe tendencies of behavior. However, there are several approaches that describe culture in a way that enables to build computational models, such as definitions using dimensions or categories in order to explain differences between certain groups. An overview of these cultural theories is given in the following.

An example of defining culture using different dimensions is given by Hofstede (2001) who categorized different cultures into a five dimensional model. His theory is based on a broad empirical survey covering more than 70 countries. Primarily, only the largest 40 countries were analyzed and extended to 50 countries and 3 regions later (Hofstede, 2009). Currently, a total of 74 counties are listed (Hofstede, 2009), whereas the scores on the dimensions are partly based on replications or extensions of the original study. Originally, Hofstede introduced four dimensions to explain different cultures. The fifth dimension, Long

Term Orientation, was added afterwards in order to explain Asian cultures in more appropriate way based on Confucian dynamism. So far, this dimension is applied to 23 countries. Each of the dimensions contains two extreme sides and every culture is thus positioned in a five-dimensional space, represented by a value on each dimension. These scores were originally supposed to be between 0 and 100. But as more cultures were added afterwards some of the countries exceeded these borders, as they were more extreme on a dimension than a country that was already rated on the most extreme value. Besides publishing the scores on the five dimensions, explanations are given on how the combinations of the dimensional positioning impact the behavior of the members of a given culture (Hofstede, 2009).

Hofstede's five cultural dimensions are Power Distance, Individualism, Masculinity, Uncertainty Avoidance and Long-Term Orientation and will be explained in the following:

(1) The dimension of *Power Distance* describes the extent to which a different distribution of power is accepted by the less powerful members of a culture. Scoring high on this dimension indicates a high level of inequality of power and wealth within the society. A low score on the other hand supposes greater equality between social levels, including government, organizations and families.

(2) The *Individualism* dimension describes the degree to which individuals are integrated into a group. On the individualist side, ties between individuals are loose and everybody is expected to take care for himself. On the collectivist side, people are integrated into strong, cohesive in-groups.

(3) The *Masculinity* dimension describes the distribution of roles between the genders, which can be a crucial characteristic for a culture. The two extreme sides are masculine and feminine, whereas masculine values contain attributes such as being assertive or competitive while members of feminine cultures have moderate, caring values.

(4) The *Uncertainty Avoidance* dimension explains a society's tolerance for uncertainty and ambiguity. The extent to which a member of the culture feels uncomfortable or comfortable in an unknown situation is the key-factor of this dimension. Uncertainty avoiding cultures try to minimize the possibility of such situations and stuck to laws and rules. Members are emotional and motivated by an inner nervous energy, whereas uncertainty accepting cultures are more tolerant to different opinions and do not express strong emotions.

(5) The last dimension, *Long Term Orientation*, was included several years later in order to explain Asian cultures better. One extreme side, Long Term Orientation, is associated with thrift and perseverance whereas the other side, Short Term Orientation, shows respect for tradition, fulfilling of social obligations and protecting one's 'face'.

According to Hofstede, behavior varies with the position on these five dimensions. In particular, the predominant dimension (the one with the most extreme score) for each culture determines the behavior of the culture's members. In (Hofstede & Pedersen, 2002), so-called synthetic cultures are introduced. The five dimensions are observed in isolation. In that vein, a synthetic culture illustrates a group that finds itself on one of the extreme sides on one of the five dimensions. For every synthetic culture a profile is defined that contains the culture's values, core distinction, key elements as well as words with a positive or negative connotation.

The extreme *individualistic* synthetic culture for example, has the core value "individual freedom" and the core distinction is the distinction between *me* and *others*. Key elements are statements such as "Honest people speak their mind.", "Laws and rights are the same for all." or "Every-

one is supposed to have a personal opinion on any topic.". These key-elements are golden rules for appropriate behavior in this culture and explain the way in which members of that culture are thinking. Positive and negative words help understanding a culture in a descriptive way. Words with a positive connotation in the extreme individualistic culture are for example: self, friendship, "do your own thing," self-respect, dignity, I, me, pleasure, adventure, guilt or privacy. Words with a negative connotation on the other hand are words such as: harmony, obligation, sacrifice, tradition, decency, honor, duty, loyalty or shame. For the extreme collectivistic synthetic culture, the connotation of these words is the other way round. Stereotypical behavior is defined for synthetic cultures as well. Extreme individualists, for example, are described as verbal, self-centered, defensive, tending to be loners and running from one appointment to the next. This dimension is predominant for the US American culture for example. But no existing culture is exclusively influenced by one dimension. The US culture for example scores high on the masculinity dimension, too. Thus, the male principle dominates the society and power structure. This generates also a female population that becomes more assertive and competitive, with women shifting toward the male role model and away from their female role (Hofstede, 2009). A combination of these two dimensions explains the culture better than looking at them in isolation.

Synthetic cultures with their values and behaviors are a valuable tool in order to understand cultures that score differently on a dimension compared to one's own culture. Due to its dimensional approach and the fact that almost all national cultures are ranked in Hofstede's dimensions, this model of culture is most commonly used in computer science.

Another approach that distinguishes cultures along dimensions was introduced by Kluckhohn & Strodtbeck (1961), who describe different value orientations in order to explain cultures. According to the authors, culture consists of explicit and implicit patterns that are transmitted by symbols and constitute the distinctive achievements of different groups. The value orientations cover the following:

(1) The essential *nature of people* varies from evil to good and explains the extent to which people are considered as being trustworthy and good or bad and if they need to be controlled.
(2) The *relationship to nature* describes what members of a culture think is the appropriate relationship to the environment. These relationships range from being determined by nature trough external forces and genetics, to the thinking that humans dominate over nature.
(3) The *relationship to other people* describes how people wish relationships and social organization to be. This is explained in shades from hierarchical (power is distributed unequally) to individual (equal rights for everybody).
(4) The *modality of human activity* is a value orientation that ranges from the simple concept of being, to the concept that efforts will be rewarded and therefore people should work hard.
(5) The *temporal focus* of human activity describes how people think about time. The orientation can be either in the past implying one should learn from history, in the present (living for today) or in the future, which results in planning and saving for the future.

Although in this theory Kluckhohn gives a classification of possible values, the impact on behavior is described rather vaguely and hard to measure. In addition, no national cultures were ranked or explained according to this concept. Building a computational model with it is thus a demanding task and has not been attempted yet.

Another well known theory was introduced by Hall, who classifies cultures using different

categories. Instead of defining dimensions, he distinguishes cultural groups depending on their perception of *space*, *time* or *context*.

In (Hall, 1966), he defines different personal spaces that surround individuals. The *Intimate Space* describes the space that is reserved for the dearest friends and intimates only. In the wider *Social Space,* people handle social interactions with acquaintances as well as strangers. Whereas in the *Public Space* interaction is considered as impersonal and anonymous, e.g. the distance between two strangers waiting at a bus stop. Hall states that expectations about these zones vary widely across cultures and violations of keeping the interpersonal distance zones are regulated immediately, e.g. through backing away from a conversation partner.

Another aspect that is perceived differently across cultures is the concept of time. In (Hall & Hall, 1987), cultures are divided into *monochronic* and *polychronic* cultures. In monochronic cultures, time is perceived in a linear way, comparable to a time line from past to future. Typical behavior patterns in such a culture are doing one thing at a time or concentrating on one job. Time commitments are taken very seriously and a schedule is perceived as unalterable and has a high priority. In contrast to this clock-time concept of culture, in polychronic cultures, time is seen in a relational way. Members of these cultures tend to do several things simultaneously, to be distractible or subject to interruptions. Time commitments are considered as being an objective to be achieved if possible. Human transactions have a higher priority than a time-schedule. To this end, individuals would rather be late for an appointment than terminating an ongoing conversation.

As mentioned earlier, Hall introduces a third category to distinguish cultures: their orientation towards *context*. In (Hall, 1976), cultures are divided into *high-context* and *low-context* cultures. In high-context cultures, little information is explicitly encoded in the communication and thus, interlocutors are expected to "read between the lines" in order to understand the whole meaning. The conversation relies mainly on physical context and not exclusively on verbal utterances. In addition, meaning is transported through context or nonverbal clues. In contrast to this, low-context communication explicitly codes information and requires a high degree of specificity. In that vein, communication partners are expected to formulate clear messages that can be understood easily by everybody. No interpretation of other aspects of communication is demanded. In regards of high and low context communication, a clear line can be drawn between Eastern and Western cultures. While most Western cultures are low-context cultures, most Asian cultures are high-context cultures.

As stated above, the focus of this chapter is the simulation of culture-specific communication styles.

Therefore, besides defining culture, the concept of communication management needs to be illustrated. Interpersonal coordination during a conversation is managed subconsciously. Communication management includes tasks such as turn taking or giving feedback to the interlocutor. Therefore so-called regulators are utilized, that can be categorized into three main groups: *Vocalics, Kinesics* and *Oculesics* (Ting-Toomey, 1999).

Vocalics include verbal feedback behavior, e.g. expressions such as "uh-huh" in the English language, as well as the usage of silence in speech or interruptions. Depending on the usage of these vocalics, a different rhythm can evolve during a conversation. The other two groups of regulators describe nonverbal behaviors that are used to manage a conversation. They can be either performed using hand gestures or body postures (*Kinesics*) or through eye and face gaze (*Oculesics*).

Ting-Toomey (1999) states that these regulators are considered culture-specific behaviors that are learned at a very young age. Thus, they are used at a very low level of awareness. Using regulators in an inappropriate manner might lead to distress. As regulators are applied differently

across cultures, frustration and intercultural misunderstandings can occur easily without being aware of it.

Since beliefs expressed in talk and silence are dependent on culture (Ting-Toomey, 1999), the application described later in this chapter focuses on the usage of verbal regulators and in particular, the usage of silence and overlaps in speech. Besides deciding whether to use verbal regulators or not, the meaning can vary across cultures, e.g. the communicative function expressed in verbal feedback. The utterance "hai hai" in a Japanese conversation, for example, simply expresses that the communication partner is listening, while the literal translation "yes yes" would transport additional meaning. But not only the function of verbal feedback varies across cultures, the frequency and positioning within the conversation is also dependent on the interlocutor's cultural background.

FROM SINGLE AGENTS TO MULTIAGENT SYSTEMS

When developing a training platform for intercultural training using virtual agents, it is not sufficient to define and discuss the concept of culture as theoretical background. The evolution of systems using virtual agents also has to be taken into account as well as the directions and future trends expected in that area.

Virtual agents or embodied conversational agents (ECAs) become more and more common in several areas such as computer games, entertainment, commerce or education. They are defined as computer-generated characters that are able to demonstrate some of the properties that humans use in face-to-face conversations such as producing and responding to verbal and nonverbal communication (Cassell et al., 2000).

In their early years, virtual agents were mainly utilized to present information in a human-like manner. Through their embodiment they were able to inform users in a natural way, using verbal and nonverbal behaviors. As presenter agents they were not reactive, neither to the user nor to other computer-controlled agents. An example is given in (André et al., 1999), where the authors introduce a presenter agent that explains the functionality of a technical device. Depending on the agent's presentation, goals and external parameters such as information about the user's knowledge, a presentation script is generated. The agent *PPP Persona* acts similar to a TV host that presents information to the human user. Interaction with the virtual agent is not possible at that point.

As a next step, virtual agents became interactive in a way that they either react to the user or other virtual agents. An example is given in (Rist et al., 2003) where an interactive presenter agent reacts to the user's questions. As natural speech interaction was still a problem at that time, the communication was reduced to chat-functionality. To this end, the user typed questions in order to communicate with the agent. The reactive agent answers according to the user input, using natural speech as well as nonverbal behaviors such as gestures and facial expressions.

Pelachaud et al. (2002) present a talking head that is able to converse with a human user by using synchronized verbal and nonverbal behaviors. Interaction with the user is not limited to chat-functionality. In this application, the user interacts with natural speech. Besides the ability to interact in a natural way, the agent is provided with a personality and a social role that allows showing emotions.

Another example is given in (Bickmore & Cassell, 1999), where a virtual agent acts in the role of a real estate agent. The embodied conservational agent is shown on a life-size screen and uses natural speech output, gestures and body postures. On the user's side natural speech as well as nonverbal interaction is recognized as input. Therefore, the user is recorded via microphones and cameras. In that vein, a natural multimodal conversation evolves. By adding small talk and

conversational storytelling capabilities to the system, the effect of human-like interaction is even intensified.

Besides interacting with a human user, virtual agents might also interact with other agents. Realizing such mulitagent systems, a whole team of agents can present information to human users in an interesting way. Rhetorical tricks such as contrasting pros and cons or repeating the most important information can be realized easily. In (André et al., 2000b), for example, such a system is introduced. A team of virtual agents is located in a car-selling application where they interact with each other in the style of a role-play. Presentations are generated depending on predefined attributes such as the agents' personalities, roles or attitudes towards the product.

An example of a presentation that cannot be planned in advance is given in (André et al., 2000a). In their application, a team of virtual agents reports about an ongoing football game for robots. Thus, information is updated constantly and the virtual agents need to generate new plans at runtime.

Bringing together the two types of interaction, either with the user or with other virtual characters, interactive performances integrating the user and several agents are a next logical step. The system described above (André et al., 2000b) was enhanced in such an interactive way. In (Rist et al., 2003), a human user participates in the car-selling scenario described above, where a group of virtual agents interacts with one another. In the virtual scene, it is up to the user how active he or she is. Thus, the story cannot be planned in advance. To integrate the user into the virtual scenario, he or she is represented though an avatar. For interaction a text-field is provided. The underlying platform foresees several agent-components, each containing a behavior planner that controls the performance in the interactive conversation in a highly dynamic way.

Another well established system that allows user-interaction with several virtual agents is described in (Mateas & Stern, 2002). This interactive story-telling approach narrates the story of a married couple that conflicts in the story line sooner or later. The behavior selection process is influenced by the user's interactions and thus, each experiences a different story depending on his or her own interactions.

In (Pizzi et al., 2007), the user is integrated into an interactive digital story as well, playing in the drama of the French novel Madame Bovary. The user affects the virtual agents' feelings through his or her interactions, which in return influences their behavior. The system is highly reactive as the characters' behavior is based on a multi-threaded planner that controls each character independently.

So far, systems that allow communication for a single user with either one or several virtual agents were discussed. Interacting in a virtual word with several human users is exemplified in (Isbister et al., 2000). In this multi-party application a so-called helper-agent intervenes in a chat environment when a conversation between two human users is about to stagnate.

Another example is given in (Rehm et al., 2008), where a multi-player dice game is described in which a virtual agent interacts with two human users. In their experimental setting, the agent takes part in the game as an active partner controlled by an emotional model. The multi-user game allows user-agent interaction as well as user-user interaction.

Summarizing the development of systems utilizing virtual agents to enhance the user's experience, a clear tendency can be seen: from virtual agents that simply present information, over agent teams that take advantage of presenting in a dialog-style, to the integration of a human user. Within systems allowing user-interaction, there are several possible developments: multi-user or multi-agent applications; which both need to be reactive and capable of planning the virtual characters' behavior at runtime.

CULTURE IN MULTIAGENT SYSTEMS

In the previous sections, several definitions of culture as well as the evolution of multiagent systems were investigated. In this section, the two topics are combined and reflect on the current state of the art in simulating culture and culture-specific differences in behavior using virtual agents. As stated above, virtual agents served as presenters of information in their early stages. In the beginning, integrating culture-related differences was not focused on yet. Thus, the first systems that introduced culture for virtual agents are located on a much later point in time and most of them already use multiple agents that interact with each other, or already integrated the user into the virtual scenario.

An investigation that analyzed the impact of the virtual agent's culture-specific appearance only, was presented by Koda et al. (2008). They investigated whether emotions are judged the same way across different cultures. Images that show different appearances for virtual characters as well as their emotional expressivity were designed for that purpose in different cultures in a comic-style manner. Their results show that subjects from different cultures perceive agents differently and that there is an in-group advantage for interpreting emotional displays.

Focusing on ethnicity rather than on culture on a national level, Iacobelli & Cassell (2007) present a virtual peer that shows different verbal and nonverbal behaviors. Leaving the appearance of the virtual agent constant and changing the behaviors only, the contribution of ethnic identity and engagement of human subjects were tested. Their results suggest that behavior override appearance in judging ethnicity.

Another example of an interactive system is the tactical language training system, described by Core et al. (2006). Human users are trained to negotiate with virtual agents that have a different cultural background than their own. The focus lies on gaining language skills. For the role-playing scenario, different negotiation styles have been implemented, however, the agent's behavior does not adapt to cultural background, although the authors state that this would be a promising next step.

Interactive environments where virtual agents meet a human user become more and more common in teaching intercultural competencies and are considered state of the art. In (Ogan & Lane, 2010), in this volume, a review of six virtual learning systems using virtual agents to teach a human learner about culture is provided. Please see their chapter for more information on how these systems simulate cultural interactions using artificial intelligence or narrative-based techniques. The authors reflect on how systems with virtual agents can be used to help the user to learn about culture and in particular on how to adapt to a given culture. In their discussion, Ogan & Lane (2010) address the domains of *intercultural skills*, *learner assessment*, and *model building and validation* as important areas in current research as well as promising fields for future research.

One approach that uses a group of virtual agents in order to simulate culture-related differences in behavior is described in (Jan et al., 2007). In their system, they present a computational model of culture that focuses on simulating aspects of non behavior, such as proxemics and gaze. Evaluating their system, a group of agents that showed culture-specific nonverbal behavior was shown to human users. Their results reveal that subjects perceived differences between behaviors that are in line with their own cultural background and behaviors from different cultural backgrounds. For their future work, they state that a multimodal corpus would be helpful for analyzing nonverbal behaviors.

A project that recorded such a database in order to find out more concrete differences in nonverbal behaviors is described in (Rehm et al., 2007a). For their empirical corpus study, they recorded three prototypical scenarios in the two cultures

Germany and Japan and analyzed differences in nonverbal behaviors for these two cultures. In (Rehm et al., 2007c), they describe an application where a group of virtual agents reacts to the user's nonverbal behavior. So far, their computational model of cultural behavior for the virtual agents relies on Hofstede's (2001) dimensional theory of culture, but will be complemented by their empirical data in the future.

SIMULTATING CULTURE-SPECIFIC COMMUNICATION STYLES: AN EXAMPLE APPLICATION

Current research on teaching intercultural communication skills using virtual agents mainly focus on simulating culture-specific nonverbal behavior or on teaching specific verbal skills, such as how to request a favor. In this work, the authors introduce an approach using a multiagent system that simulates different culture-specific *communication management* behaviors. Therefore the focus lies on verbal regulators (Ting-Toomey, 1999) such as the usage of silence in speech and overlapping speech. In that vein, the authors position themselves between verbal and nonverbal behavior, as they consider differences in the way people communicate verbally with each other, without taking into account the semantics of the speech.

The way communication is managed can be very different across cultures and several patterns and in particular combinations of these patterns can be crucial for a certain culture. In the literature, not much information can be found on how communication is managed in specific national cultures. Thus, as a starting point the authors had a closer look at differences in communication management between Asian and Western cultures, since a lot of differences can be found for these two cultural groups in the literature.

Considering pauses in speech, Hofstede (2002) states that silence may occur in conversations without creating tension in collectivistic cultures (most Asian cultures), which does not hold true for individualistic cultures (most Western cultures). Strengthening this idea, Ting-Toomey (1999) claims that silence serves as a critical communication device in Japanese communications. According to her, pauses in speech can reflect the thoughts of the speaker and thus can contain strong contextual meanings. In Western conversations, in contrast, pauses are often sensed as unpleasant or seen as a failure of communication.

Another distinction of Western and Asian communication patterns is described in (Trompenaars & Hampden-Turner, 1997). Cultures are categorized into the three groups: Anglo Saxon (Western), Latin and Oriental (Asian). Western cultures are described as being verbal societies, where members become nervous and uneasy once they stop talking. Asian cultures in comparison are considered as more silent. According to Trompenaars & Hampden-Turner (1997), in Asian communications pauses in speech are often seen as a sign of respect and as taking time to reflect on the information that was given by the interlocutor.

Another regulator that controls the flow of a conversation is the use of overlapping speech, which is highly dependent on culture as well. In the Hungarian and French cultures, for example, interrupting the conversation partner is considered as showing interest in the communication. In Japan for example, such behavior is regarded as being rude or impolite in the sense of braking into the conversation, or not waiting for the conversation partner to finish his or her turn. According to Trompenaars & Hampden-Turner (1997), a line can be drawn between Asian, Western and Latin cultures concerning the deployment of overlapping speech. While interruptions that are meant for taking the speaking floor are often seen as impolite in Western cultures, they are interpreted as interest in Latin cultures. In Asian cultures controversially, overlapping speech serves another purpose. According to Ting-Toomey (1999), the main function is to give feedback. Therefore, people are actively

communicating that they are listening, by using utterances such as "hai hai" while the other conversation partner is still speaking.

Summarizing the tendencies described above, derived from literature, the following conclusions can be drawn on differences in the management of communication for Asian and Western cultures: there should be more pauses in speech as well as more overlapping speech in simulated Asian conversations than in Western ones.

These tendencies provide initial evidence, on how to integrate differences in the management of communication in dialogs for virtual agents. However, for their implementation the authors need more precise data than simply stating "more silence" or "more overlaps in speech". Another limitation so far is that the tendencies described above explain patterns for cultural groups rather than for concrete cultures, as behavioral differences within these cultural groups can be crucial as well. Japan and China, for example, are both Asian cultures, but while China is considered as being rather loud, Japanese people are often described as being modest and polite.

For the demonstrator with virtual agents, the authors focus on two particular cultures. In order to ground the tendencies found in the literature into empirical data for two national cultures, the multimodal corpus collected for the CUBE-G project (CUlture-adaptive BEhavior Generation for interactions with embodied conversational agents) (Rehm, 2007a) was analyzed. For the acquisition of this video data, three prototypical interaction scenarios were recorded in Germany and Japan (representing a Western and an Asian culture). In a total, around 20 hours of video material were collected, with more than 20 participants from each culture. All subjects interacted with actors whom they did not know in advance.

Focusing on communication management behavior, the authors analyzed eight German and eight Japanese conversations from the first interaction scenario. In order to exclude behavioral differences that were aroused by gender, four male and four female subjects were taken into account from each culture. Thereby, every possible gender combination was considered.

As mentioned above, one clue of communication management is the usage of pauses in speech. In the corpus analysis, time spans in which neither subject nor actor spoke were considered as a pause. Brief pauses (smaller than one second) that might occur while breathing or between sentences are not likely to be used for communication management purposes and were thus excluded from our analysis. Later the authors even restricted to pauses that lasted for more than 2 seconds. Comparing the two cultures differences are obvious. On average, 7.1 pauses that lasted for more than 1 second and 1.3 pauses that lasted for more than 2 seconds were found in the German videos. In the Japanese videos, 31 pauses that lasted for more than 1 second and 8.4 pauses that lasted for more than 2 seconds were found on average. Each of the videos lasted for approximately 5 minutes. Comparing the averages, thus more than four times the amount of pauses that lasted for more than 1 second were found, and more than 6 times the pauses that last for more than 2 seconds in the Japanese conversations than in the German ones. These findings are highly significant using the t-test for statistical analysis, both with p values < 0.001. In addition, these results are in line with tendencies described in the literature.

To ensure that our results were not evoked by gender, an inner-cultural analysis was performed as well. Therefore, female with male subjects and mixed versus same gender constellations were compared in each culture separately. For both cultures, no significant results were found, comparing genders or gender combinations.

As stated above, another cue for communication management is the usage of overlapping speech. Analyzing the same videos described above, time spans where both conversation partners spoke at the same time were considered as overlapping speech. Pragmatics such as using overlaps for feedback behavior in comparison to

overlaps that are used for gaining the speaking floor, were not taken into account yet. On average, the authors observed 46.6 overlaps in the Japanese videos and 32.1 overlaps in the German videos. Comparing the two cultures, results are less obvious as for pauses in speech, but still significant using the t-test (with a p-value = 0.04). Having a closer look at longer overlaps (lasting for more than 0.5 seconds and more than one second respectively), no significance was achieved, but still clear tendencies. On average, 12.4 overlaps that lasted for more than 0.5 seconds and 2.6 overlaps that lasted for more than 1 second were found in the German videos, while 14.5 overlaps that lasted for more than 0.5 seconds and 4.3 overlaps that lasted for more than 1 second were found in the Japanese data. Finding more overlapping speech in Asian conversations is in line with suggestion found in the literature.

To simulate these findings in a multiagent system, the authors use the Virtual Beergarden developed at the Augsburg University, running on the Horde3D GameEngine (Augsburg University, 2009). In the virtual scenario, an arbitrary number of virtual agents can interact with each other using a text-to-speech engine and nonverbal behaviors. The characters' appearance (skin, hair or shape of the face) has been adapted to their cultural and ethnic backgrounds. Accordingly, prototypical Asian looking and prototypical Western looking characters were designed. In Figure 1, the differences between agents representing these two cultural groups are demonstrated.

Besides the appearances of the virtual agents, there are several other features that might influence the judgment of human observers such as the agents' gender or the semantics of their speech. In order to allow human observers to concentrate solely on communication management behavior, they should not be distracted by the content of the conversation. To this end, a fantasy language was used in the simulation, called Gibberish. A Gibberish Generator (Enevoldsen, 2009) generates text that has the same statistical distribution of alphabetic characters or combinations of characters as an input text. Using a text-to-speech engine, the output thus sounds similar to the target language without having any meaning.

Another distracting factor might be the agents' genders. In order to exclude differences in the perception of the cultural models that are aroused by gender, only mixed gender combinations were considered in the simulated dialogs. Thus, a female and a male virtual character interacted with each other.

In order to integrate the findings described above into the multiagent system, two different cultural models were designed: one demonstrating

Figure 1. Virtual agents with different culture-related appearances in the virtual beergarden application (left: prototypical Asian looking characters, right: prototypical Western looking characters)

prototypical Japanese communication management behavior and one showing prototypical German communication management behavior.

According to the literature, more silence is found in Asian conversations than in Western ones. This tendency was supported by our corpus analysis for German and Japanese pause behavior. Thus, more silent traces were integrated into the exemplary Japanese agent dialog than in the exemplary German one. As pauses in speech are not an impossible event in Western communication, they were not excluded them per se, but reduced them to a minimum. Following the analysis of the video data, the German simulated dialogs contained one pause that lasted for 1 second, in contrast to the Japanese version which contained two pauses that lasted for 1 second and one pause that lasted for 2 seconds. These amounts were calculated taking into account the length of the videos (approx. 5 minutes) and the length of the simulated agent dialogs (approx. 0.5 minutes).

A similar approach was realized for simulating differences in overlapping speech. Following tendencies described in the literature for Asian and Western cultures and strengthened by our corpus study comparing German and Japanese subjects, more overlaps in speech were integrated into the prototypical Japanese behavior model than in the prototypical German one. Following the analysis, one overlap that lasted for 0.3 seconds and two overlaps that lasted for 0.5 seconds were added to the German dialog. Three overlaps that lasted for 0.3 seconds, one that lasted for 0.5 seconds and one that lasted for 1 second were shown in the Japanese conversation.

To allow observation of the different regulators that are used to manage communication in isolation, different subversions of our behavioral models were built. Thus, the agent dialogs either contained both features, pauses and overlapping speech, or show one of these two behaviors per se. Accordingly, the risk that one behavior is dominant over the other or that differences in perception are caused by only one of them, could be excluded. Showing the agent dialogs to human observers, first results are promising. In a preliminary evaluation study (Endrass et al., 2009b), German subjects judged both behavioral models that were presented by the prototypical Western-looking virtual agents. To ensure that subjects do not estimate a cultural background different from their own, a German text-to-speech engine was used as well as a German input text to generate the Gibberish. The perception study was designed in order to find out whether subjects are able to distinguish the different versions of agent dialogs. Results are promising for all three versions of our behavior model that were shown in alternating order. 12 subjects rated the videos on a 6 point Likert scale. Results showed that German subjects preferred agent dialogs that simulated prototypical German behavior. Using the two–sided t-test for statistical analysis, significance for all three versions was achieved: different usage of pauses in speech (with $p < 0.02$), differences in overlapping speech (with $p < 0.002$) and the combined version (with $p < 0.002$). This suggests that subjects do perceive a difference between culture-specific dialogs that are in line with observations made for their own cultural background and agent dialogs that are not.

Furthermore, the authors found out that subjects were aware of the reasons why they preferred a certain conversation, as some of them explicitly named the differences in pauses or overlapping speech or stated that the version differing from their cultural background was distracting for them.

The authors thus claim that our approach of using a multiagent system to simulate culture-related differences in behavior indeed can be used to achieve cultural awareness in human observers and that this is a promising area for future research.

Regarding our approach of integrating culture-related differences in communication management behavior into a multiagent system, several steps need to be done as a future work. First, the same perception study needs to be perfromend with Japanese observers and prototypical Asian-looking virtual agents. In inference, Japanese subjects are

expected to prefer the simulated Japanese agent dialogs. Secondly, the authors aim at conducting a qualitative analysis in order to get a deeper insight into the communicative function of pauses in speech and overlapping speech. In particular, the authors want to investigate if e.g. overlapping speech is effectively used for feedback behavior in Japanese conversations and if the corresponding simulated dialogs have any impact on human observers. In addition, semantics should be integrated into the dialogs as well as culture-specific nonverbal behaviors. A next step will also be to integrate the user into the virtual scenario.

THE FUTURE OF CULTURE IN MULTIAGENT SYSTEMS

As described earlier, the evolution of multiagent systems went from single agents that presented information, to reactive agents that either interact with other virtual agents or a human user. Although preliminary, both of these interaction types have been implemented successfully in order to achieve cultural awareness on the user side. Rehm et al. (2007c) for example, presented an approach of integrating the user into a group of virtual agents, that change their behavior according to their assumptions about the user's culture that was derived from observations of his/her nonverbal behavior. In (Endrass et al., 2009b), different culture-specific styles of communication management behavior is shown by a group of virtual agents in order to demonstrate differences in behavior to a human observer.

In the future, preferably verbal and nonverbal behaviors will be combined to enculturate virtual agents with a richer repertoire of behavioral skills. Culture-related differences are expressed through several channels and thus, different kinds of expressing culture could be considered. In that vein, virtual agents should be used with all their abilities of showing culture-related differences, such as: gestures, postures, eye-gaze, proxemics behavior, tone of voice, flow of speech, content of communication, turn taking behavior, just to name a few.

Considering the overall trend of multiagent systems, a next plausible step would also be to build an application where multiple users and multiple virtual agents communicate with each other. Such an approach is described in (Aylett et al., 2009), where an educational application is introduced that was designed to develop inter-cultural empathy in participating users. Fantasy characters have been designed with their own symbols, rituals and culture. Besides culture, emotions and personality are influencing the agents' behavior. To achieve cultural awareness, a group of users interacts as a team with a group of virtual agents. However, in their system no awareness for an existing culture or culture-specific behavior is trained, but an overall awareness of something that is different from one's own culture, as their scenario is located on another planet and the characters are fictive.

In line of this research, the authors aim on building an application with enculturated virtual agents that allow multi-user participation. By realizing that, users are not only able to learn by observing virtual agents interacting with each other, but also from possible pitfalls or positive achievements experienced by other users. In (Endrass et al., 2009a), a system architecture is introduced that provides planning of coherent behavior for an arbitrary number of virtual agents. Furthermore, the system architecture allows multiple users to interact with each other as well as with the participating virtual agents. In the near future, the author's intent to use this framework in order to build an application that simulates culture-specific behavior for a group of virtual agents that is able to communicate with several human users.

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KEY TERMS AND DEFINITIONS

Communication Management: The interpersonal coordination during a conversation is often managed subconsciously. Communication management includes tasks such as turn taking or giving feedback to the interlocutor.

Cultural Awareness: Being aware of the fact that differences in behavior or thinking can be aroused by culture. According to Hofstede (1991), cultural awareness is the first step towards gaining intercultural competences.

Cultural Training with Virtual Agents: Virtual Agents can be used in order to gain intercultural competencies. This can either be accomplished by observing Virtual Agents that perform culture-specific behavior or through interaction with Virtual Agents.

Multiagent Systems: In a Multiagent System as it is propagated here, several Virtual Agents are located in a virtual world with the ability to communicate with each other.

Regulators: Regulators are tools that are used to manage the flow of a communication. Ting-Toomey (1999) categorizes regulators into Vocalics (e.g. verbal feedback or silence), Kinesics (e.g. gestures or postures) and Oculesics (e.g. head or eye-gaze).

User Interaction: The possibility to interact with a computer controlled system is given to the user. User input can be realized by diverse devices such as text-fields, microphones or cameras. The system needs to be reactive and adjust its behavior depending on the user input.

Virtual Agents: Virtual Agents are computer controlled virtual characters that interact verbally and nonverbally.