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Abstract. The goal of this paper is to integrate culture and social relationship as a computational term in an embodied conversational agent system by employing empirical and theoretical approach. We propose a parameter-based model that predicts nonverbal expressions appropriate for specific cultures in different social relationship. So, first, we introduce the theories of social and cultural characteristics. Then, we did corpus analysis of human interaction of two cultures in two different social situations and extracted empirical data and finally, by integrating socio-cultural characteristics with empirical data, we establish a parameterized network model that generates culture specific non-verbal expressions in different social relationships.

Keywords: Culture, Social relationship, Posture, Bayesian network.

1   Introduction

When people interact, their interaction patterns and behavior, such as the distance they stand from each other, posture, facial expression, how much they gaze at one another, and many other attributes depend on the interpersonal relationship existing between them and the geographical boundary which is dictated by the culture to which they belong [6]. Behavior regarded as friendly in one culture may, thereby, be interpreted as inappropriate or impolite in another. Thus, in an era of globalization, there is an increasing need for a raised awareness of the culturally specific behaviors associated with various social relationships.

   In order to identify the culture-specific behaviors involved in such interactions, this study set out to develop a socio-cultural model in relation to non-verbal behaviors for the purpose of creating appropriate nonverbal expressions specific to postures through utilizing Embodied Conversational Agents so that users would be able to experience culture-specific postures in situations involving different social relationships. In order

to formulate such a socio-cultural model, two issues initially needed to be addressed: 1) describe culture and social relationships in a precise way and 2) identify reliable empirical data.

With regard to the first issue, theories that have examined culture and social relationships need to be evaluated. Hofstede's dimensions [7] pertaining to cultural characteristics were accordingly employed for the purpose of explaining culture that are defined using five criteria, each of which are quantitative, and consist of: hierarchy, gender, identity, uncertainty, and orientation. Importantly, Hofstede's dimensions rely on variables that are more directly linked to social and organizational processes that focus specifically on human values, rather than on general beliefs and practices. For the purpose of explaining social relationships, we carried out a general assessment of previous studies and from this, and also based on copious studies relating to social psychological research, four parameters were identified that were able to categorize social relationships: power, sense of like mindedness, frequency of contact, and length of relation.

With respect to the second issue, the identification of appropriate empirical data was initially required. Unfortunately, the material available in the literature was not specific enough and there was also little quantitative data that could be used for empirical purposes. As a consequence, data from human subjects from Germany and Japan were compared and analyzed in relation to two specific kinds of social relationship where a first meeting and interactions takes place with a higher status individual.

Through integrating theories of culture and social relationships with empirical data, we were thus able to update the socio-cultural model [1] that was employed in the present paper, which generates culture specific non-verbal expressions. Our ultimate aim is not only to construct a model that can specify embodied conversational agents, but also to propose a general model, which can assess nonverbal criteria for a variety of cultures in different social relationships.

This paper is organized in the following way. In Section 2, previous studies will be reviewed whereas socio-cultural characteristics will be briefly outlined in Section 3. Section 4 will describe the empirical data as extracted from the review of available research and Section 5 will present an updated version of the socio-cultural model which will be linked to the combined socio-cultural criteria and empirical data. Section 6 will present concluding remarks and recommend directions for further research in the field.

2   Relevant Studies

Many studies have shown that culture affects nonverbal behavior, such as gesture, posture, and proxemics [2, 3, 8, 9, 14]. In a study of avatar mediated communications, Nakanishi et al. [18] developed a virtual meeting space where human-human communications were mediated by avatars that allowed the cultural gap between communicators to be compensated for. In their study, a cross-cultural experiment was carried out where subjects from two cultural backgrounds were recruited and asked to interact through engaging in safe topics relating to, for example, the movies, music, sports, weather, and also unsafe topics concerning money, politics and religion. The

agent normally remained at some distance but intervened in the conversation regarding the topic under discussion by the subjects only when the latter had temporarily ceased to communicate. The researchers of the study were interested in the influence the agent exerted on the different interaction styles of subjects, who were from two different cultural groups, i.e., American and Japanese. It was found that, during the safe topic the agent exerted a more positive effect on the American compared to the Japanese subjects, whereas during the unsafe topic the presence of an agent influenced both groups equally and the subjects also felt the conversation was more interesting.

In addition to culture, social relationships are also an important for specifying nonverbal behaviors [4, 8, 6, 11]. [4] Demonstrates how non-verbal behaviors are associated with high and low social power, where different types of non-verbal attributes such as posture, gesture, head movement, gaze, proxemics, and other criteria were examined, and where significant results were also found for each category. In the case of postural behavior, it was established that individuals with greater authority were believed to have a more erect posture, lean forward more, display an open body position, and orient themselves towards others. An individual with great authority was also expected to shake, tilt upwards, and orient the head towards others more often.

Such findings in human communication studies have been exploited for the purpose of developing virtual agents for investigating behavior in foreign cultures. In this respect, the ORIENT educational application [19] consists of an agent oriented role-play system designed to create cultural empathy for 13-14 years old students. A culture-specific character was thus developed where 13-14 year olds were asked to carry out role play with an agent, who was designed as someone from another planet, in an imaginary artificial culture based on the cultural theory of Hofstede. The procedure involved adolescents initially being introduced to a foreign culture where they attempted to become accepted by that culture by means of an agent from the culture itself. This role based interaction thereby allowed adolescents to become empathic towards another person from a foreign country and, in this way, a link could be forged between behavior and culture through the creation of a believable agent.

In order to formulate such culturally adaptive behaviors using agent systems, computational models and mechanisms for the realization of nonverbal behaviors in agents were required. In order to achieve this, [2] provided a model that simulated culturally specific behaviors using virtual agents, where a set of parameters specifying proxemics, gaze, and overlap in turn-taking for Anglo American, Mexican, Spanish, and Arabic individuals. One of the shortcomings of this approach the researchers found, however, concerned the lack of data that reflected real cultural behavior, especially in relation to quantitative data for gaze and overlap in turn-taking with regard to the literature on Arab culture, which has led to approximations having to be employed based on qualitative descriptions. Bogdanovych et al. [21] has also put forward a model that relies on virtual culture in a 3D virtual world based on the environment, objects, and knowledge associated with a particular culture. In their study, the emphasis was placed on cultural knowledge, the dissemination of culture, and social relationship factors as a way to model culture.

The literature provides a great deal of information as to how communicative behavior is influenced by culture and social relationships yet precise quantitative data is virtually absent from such sources which could potentially be exploited in a technical way to model culture computationally. As a consequence, in the present paper, we first defined socio-cultural traits and then analyzed the human communicative behavior of two cultures involving two different kinds of social relationship. Following this, socio-cultural theories were integrated with both the empirical results obtained from the analysis and the proposed socio-cultural model, which were employed in the present study for generating culture specific to non-verbal expressions in ECA.

3   Cultural and Social Characteristics

From a theoretical approach, we employ Hofstede theory to describe cultural characteristics and take social psychologist description to explain social characteristics. In this section, we described the socio-cultural characteristics in detail.

3.1   Cultural Characteristics

We start with introducing Hofstede theory [7]. Hofstede defines culture as a "the collective programming of the mind that distinguishes the members of one group or category of people from others."The theory consists of the following five dimensions, which are based on a broad empirical survey.

1. Hierarchy *(Small/Large)*: Hierarchy is the extent to which the members of society accept unequal distribution of power. This affects the behavior of both less powerful and more powerful members. The fundamental issue addressed by this dimension is how a society handles inequalities among people. This has consequences for building institutions and organizations.
2. Identity *(Individualism/Collectivism)*: This is 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 herself/himself. On the collectivist side, people are integrated into strong and cohesive groups.
3. Gender *(Masculinity/Femininity)*: The gender dimension describes the distribution of roles between the genders. In feminine cultures the roles differ less than in masculine cultures, where competition is rather accepted and status symbols are of importance.
4. Uncertainty *(Weak/strong):* The tolerance for uncertainty and ambiguity is defined in this dimension. It indicates to what extent the members of a culture feel either uncomfortable or comfortable in unstructured situations which are novel, unknown, surprising, or different from usual.
5. Orientation *(short/Long)*: This dimension distinguishes long and short-term orientation. Short-term orientation stands for a society fostering virtues oriented towards persistence and perseverance, thrift, ordering relationships by status and observing this order by having a sense of shame. Long-term orientation stands for a society fostering virtues of personal steadiness and stability, protecting face, respect for tradition and reciprocation of greetings, favors and gifts.

Since cultural characteristics in Hofstede theory are synthetic, a set of parameter values indicates the cultural profile. Fig. 1 gives Hofstede's ratings [2] for Germany and Japan. For example, in Gender dimension, Japan (95) is more masculine society than Germany (66).
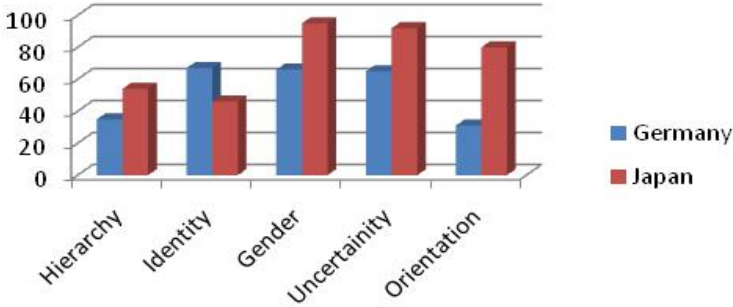

Fig. 1. Hofstede ratings for Germany and Japan

3.2 Characterizing Social Relationship

Wierzbica [22] claimed that the concepts and ways of describing social relationships have not been exact enough thus leading to the term being employed differently by various investigators. Wierzbica also emphasized how the terminology used by researches in the area of cross-cultural pragmatics also tended to be too imprecise. For example, the term "intimacy" is used as "directness," "spontaneity," "solidarity," "self expression," "frequency of contact," and so on, by researchers from different cultures without explaining what exactly is meant by the concepts. In comparing the way in which researchers have employed such terms, it is obvious that the same concept is not being used uniformly. Moreover, Spencer-Oatey [11] claimed that the way social relationships are referred to remains imprecise and, secondly, people from different cultures regard social relationships in various ways. For example, in western culture the vertical relationship associated with "power" is seen in a negative way, whereas in both China and Japan this is regarded as positive. Thus, a person who is "superior" does not simply dominate or control a person of lower status as the individuals involved are regarded as being bound together in a relationship, which involves extensive mutual ties and responsibilities.

In this study, we employed the following four criteria which have been previously defined by [11] for the purpose of measuring social relationships.

1. Power *(High/Low)*: By power we mean the power of the speaker over the hearer in a given role involving a relationship. One person is thereby regarded as holding power over another in the sense that such an individual is able to control the behavior of another. Power can also be based on several factors, such as physical strength, wealth, age, institutional role [11].

2. Sense of like mindedness *(High/Low)***:** This concept refers to the situation where similar views are held that leads to a strong relationship between two individuals [11].

3. Frequency of contact *(High/Low)***:** This refers to a social dimension that is horizontal in structure that determines the format of a relationship. Frequent contact [11] refers to distance/intimacy.

4. Length of relation *(Long/Short)***:** This term also refers to how roles in a relationship are measured. The duration of the relation hence influences the amount of closeness in a relation [11]. In cross-cultural research it has been established that individuals from different cultures regard this factor differently. For example, friends are regarded as close by Lim and Bowers but as intermediate in terms of closeness/distance by Blum-Kulka et al [11].

4   Comparative Corpus Analyses

Evidence derived from the literature indicates that both verbal and non-verbal behavior consists of an assimilation of social and cultural factors. In the present study, we examined posture as one kind of non-verbal behavior. Fig. 2 presents an example of this, where it can clearly be seen that, in the first situation, where the individual is interacting with someone for the first time, the posture of the person is more relaxed than in the second scenario where the interaction involves someone of a higher status. Posture can, therefore, be exploited as a way of determining the relationship between individuals.

First time   Higher Status

Fig. 2. Interaction in two social relationships in a Japanese person

In the present study we carried out an empirical study of posture. Based on previous studies [1], posture was therefore categorized according to five criteria as follows: frequency, duration, mirroring, spatial extent, and rigidness. Brief definitions of the characteristics appertaining to posture are provided below.

1. Frequency: Frequency of change in posture
2. Duration: Duration till which a person remains in the same posture
3. Spatial Extent: Amount of space used in a posture
4. Rigidness: Rigidness or relaxation apparent from the posture
5. Mirroring: Frequency of instances when an individual unconsciously imitates a partner's posture during a conversation.

We subsequently analyzed the influence of these factors in terms of variations in culture and social relationships. We thus initially collected data on posture from an international German-Japanese project referred to as CUBE-G. Details of the data from the CUBE-G project are provided in [12].

4.1 Analysis of Corpus Data in Relation to Cultures

In this section, we analyzed the characteristics of posture studying CUBE-G data based on two cultures: German and Japanese. We annotated the head, leg and arm posture using Bull's coding scheme [15] in relation to first time conversations involving eight German and nine Japanese cases. For the head posture, we took 6 categories, for arm posture we took 16 categories and for leg posture we took 4 categories of posture shapes/types from Bull's coding scheme [15].

As cultural differences were only found for the arm postures, and not for the leg and head postures, these were therefore examined. Table 1 sets out the arm posture changes that were extracted from studying the data of German and Japanese cultures involving first time interactions. The values for "Frequency," "Duration," and "Mirroring," were derived by calculating the average number of posture shifts observed in the main data of the present study. In order to specify the value for "Spatial extent" and "Rigidness" we took the frequently occurring arm postures. Details as to how we formulated the value of each of the posture traits in relation to culture is provided in [1], [17].

Table 1. Posture characteristics affected by cultural variation

Culture	Frequency	Duration	Mirroring	Spatial Extent	Relax
Japanese	4.60	12.26	5.50	1.97	2.38
German	8.08	7.79	0.88	4.04	5.56

Table 1 indicates that the Japanese tend to engage in less frequent postures, remain in the same posture longer, engage in more frequent mirroring, take up less space, and display a more rigid posture in comparison to Germans, which represents findings which have been supported by previous studies. Sanchez-Burks [8], for example, has pointed out that members of cultural groups that are collectivistic in nature tend to display more behavioral mirroring than those from cultural groups that are more individualistic. The findings from the present study therefore support the notion that a collectivistic culture (Japanese) displays a higher incidence of mirroring than in an individualistic culture (German).

4.2 Analysis of Corpus Data in Relation to Social Relationships

Following the above procedure, we then studied the main data from the CUBE-G project in relation to two different social relationships namely, a first time encounter and an interaction with someone of a higher status. Details from the main analysis for two different social relationships are given in [17]. The way in which posture is affected by variation in social relationships is indicated in Table 2.

Table 2. Posture as affected by two kinds of social relationship

Culture	Social Relationship	Frequency	Duration	Mirroring	Spatial extent	Relax
Japanese	First Time(FT)	4.60	12.26	5.50	1.97	2.38
	Higher Status(HS)	1.32	43.52	0.00	0.54	0.73
	Proportion(FT/HS)	3.48	0.28	0.00	3.63	3.29
German	First time	8.08	7.79	0.88	4.04	5.56
	Higher status	2.38	20.43	0.00	0.98	1.44
	Proportion(FT/HS)	3.40	0.38	0.00	4.10	3.85

Table 2 shows that, in both cultures, German and Japanese, frequency is decreased, duration is longer, no mirroring occurs, posture made is smaller and more rigid when interaction is going on with high credential person than with someone for the first time. The evidence from previous studies supports these results. In the case of mirroring, for example, our results indicate that no mirroring occurs with regard to interactions involving high status individuals which provides support for study [8] that, as low power (relative to one's interaction partner) generally prime people to be relationally vigilant, and thus make the less or absence of behavioral mirroring The fourth and seventh rows in Table 2 also indicate that the proportions (FT/HS) for each variable are similar for the two cultures. For example, the proportion relating to Frequency in Japanese culture comes to 3.48 and that for German culture 3.4, which suggests that social relationships affect non-verbal behavior in both cultures in a uniform way.

5   Establishing a Socio Cultural Model Based on Empirical Data

By combining the empirical data extracted from the main analysis involving socio-cultural characteristics, a network model was thereby able to be created. In creating this network model, many questions arose such as how a social, cultural, and behavioral network might first arise; what comes first, social criteria, cultural factors, or non-verbal behavior?; can culture and social factors help in promoting non-verbal norms or, conversely, do non-verbal norms underpin culture or social relationships.

5.1   The Relationship between Social Factors, Cultural Factors, and Non-verbal Behavior

Evidence deriving from previous studies has shown how culture influences the way individuals interpret and evaluate social interactions [14]. In South Korea and Japan, for example, rigid posture indicates that a person holds an influential position whereas in America a relaxed posture gives the impression that a person is credible [14]. In addition, and as explained in section 3, the vertical concept of "power" is regarded as positive by the Japanese and Chinese whereas this is seen as negative by westerners [11]. Thus, cultures tend to vary in attitudes towards social roles and relationships.

The question therefore arises as to the way in which social and cultural factors may be linked to non-verbal behavior. In fact, socio-cultural attributes and non-verbal behavior may continuously influence one another and interact in dynamic and complex ways.

5.2 Reason for Employing a Bayesian Network

We employed a Bayesian network to represent the model used in the current study as this is capable of being exploited in a bi-directional way. Therefore, the model can be used to set or modify the nonverbal behavior of an agent by setting the evidence for a given culture and social relationship as well as to infer the cultural background and social situation from given nonverbal behavior. .A further reason for employing a Bayesian network as the basis for modeling relates to its ability to deal with incomplete and unpredictable information as well as uncertainties at any stage of operation. This capability is crucial for present purposes as the link between social, cultural, and nonverbal behavior involves a many to many mapping procedure.

5.3 The Parameter-Based Socio-Cultural Model

In order to create a Bayesian network that is able to predict non-verbal behavior, the GeNie [13] modeling system was employed. Fig. 3 illustrates the updated version of the Bayesian network as employed in the present model. To maintain consistency with the previous model we had created [1], a social relationship layer was added. In designing this new model, we carefully investigated the empirical results obtained from the present analysis with regard to the two social relationships outlined i.e., a first time encounter and an interaction with someone of a higher status. Based on the
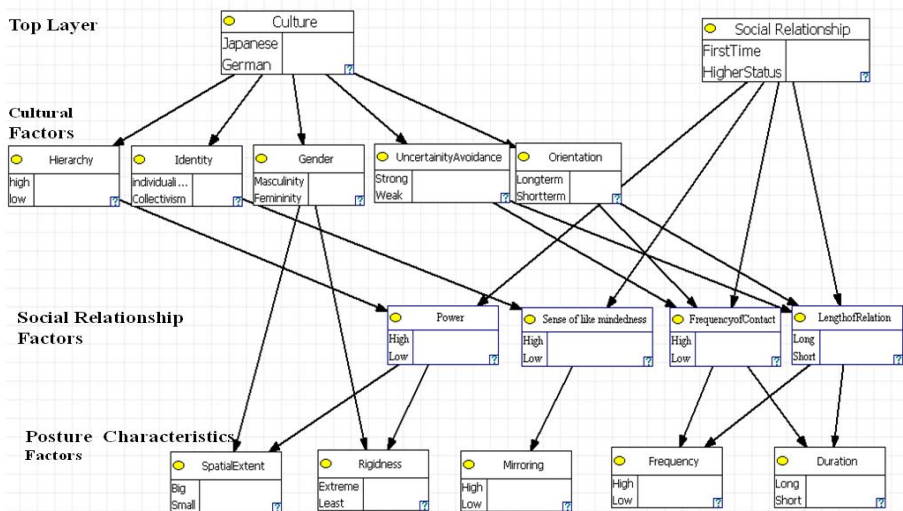

Fig. 3. Bayesian network model for predicting posture characteristics

analysis, we determined which factor or node should be linked to which node in the next layer. Details regarding the design network can be found in [20]. A summary of the network design employed in the present study is shown below.

Top layer: The entry nodes for the Bayesian network consist of a culture and a social relationship node. Culture is connected with Hofstede's dimensions and social relationship is connected with social characteristics. In the existing study, German and Japanese cultures have also been included, as well as the two social relationships with regard to a first meeting and an interaction with a high status individual.

Cultural factors: The layer relating to cultural factors defines Hofstede's five dimensions. As shown in Fig. 1, Hofstede's ratings for each culture have been used for the probabilities in each node for each culture.

Hofsted's cultural factors were linked to the factors for social relationship, as culture influences how various individuals behave in different social relationships. The details regarding the connections for these nodes are provided in [20].

Social relationship factors: The next layer concerns social relationship criteria. The probability of each node being affected as a result of cultural factors and social relationships is set out accordingly. The probability assigned was based on the cultural factors of Hofsted's dimensions as given in Fig. 1, as well as the data obtained from the main study regarding interactions in a first meeting scenario including those with a high status person, which are set out in Table 2.

Posture characteristic factors: The lowest layer consists of the posture characteristics. To assign the probability for each node, we took the empirical data extracted from the main analysis as set out in section 4. For example, for the node Frequency in the Bayesian network, we calculated probability to be 0.66 in the German case and 0.34 for Japan, since the posture shift frequency of the German data (8.075) is 1.75 times that of the Japanese data (4.6).

5.4 Examples of Predicting Postures

When a culture and a social relationship are chosen at the top level as evidence, posture characteristics are estimated. For example, as shown in Fig. 4, when *German is* selected as evidence for Culture and *First time Meeting* as evidence for Social Relationship, the results for spatial extent is large (51%), rigidness small (51%), mirroring high (52%), frequency high (51%), and duration short (51%).

As shown in Fig 5, by retaining *German* as an evidence for culture and selecting *Higher Status* as evidence for Social Relationship, the results for spatial extent are small (51%), rigidness extreme (52%), mirroring small (79%), frequency low (52%), and duration long (51%). Note that the posture of the German subject in Fig 4 is changed to one that is smaller and more rigid in Fig 5 when interaction takes place with someone of a higher status.
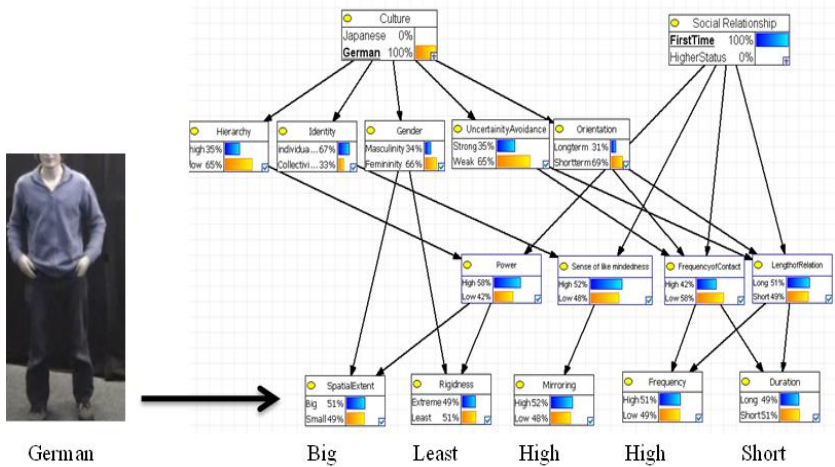
Fig. 4. A German with big and relaxed arm posture interacting with someone for the first time, and the Bayesian Network predicting posture characteristics for German culture in a first time meeting
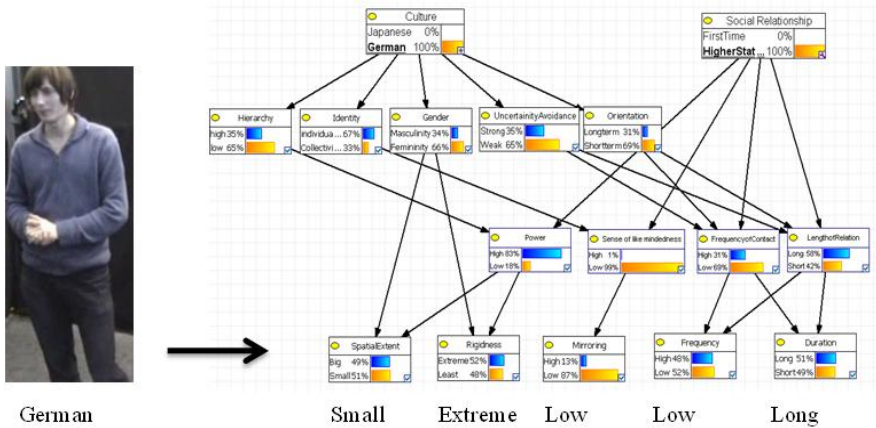

Fig. 5. A German with small and rigid arm posture interacting with someone of higher status, and the Bayesian Network predicting posture characteristics in German culture for higher status

As shown in Fig. 6 taking *Japan* as an evidence for culture and *First time Meeting* as an evidence for Social Relationship, the results for spatial extent are small (66%), rigidness the smallest (67%), mirroring high (57%), frequency high (55%), and duration short (54%).
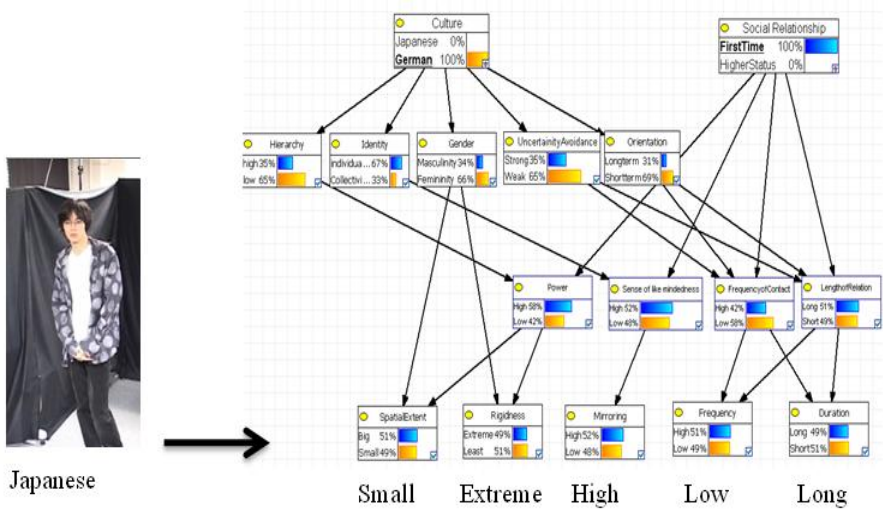
Fig. 6. A Japanese with small and rigid posture interacting with someone for the first time, and the network model predicting the posture characteristic in Japanese culture during a first time meeting

As shown in Fig.7, keeping *Japan* is as an evidence for culture and selecting *Higher Status* as evidence for Social Relationship, the results for spatial extent are smaller (68%), rigidness more extreme (69%), mirroring the least (87%), frequency lower (56%), and duration longer (55%). In a similar way as in the German example shown in Fig. 4 and 5, the posture for the Japanese subject in Fig. 6 changes to a smaller and more rigid one in Fig. 7 when interacting with someone with a higher status.
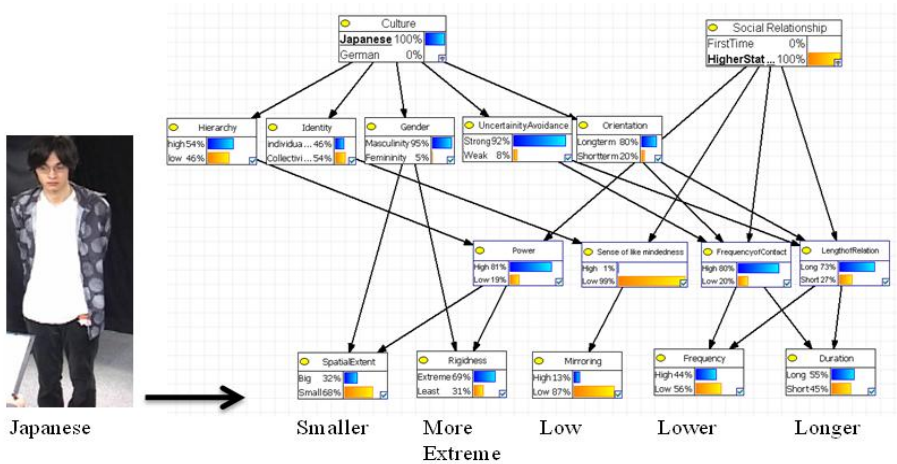

Fig. 7. A Japanese with smaller and more rigid posture interacting with someone of a higher status, and the network model predicting the posture characteristics for Japanese culture with regard to higher status

By providing empirical data for different cultures and social relationships, the model presented here is able to estimate the nonverbal criteria for any culture in different social relationships, and therefore provides a model for identifying the non-verbal factors in any culture or social relationship.

6 Conclusion

In the present study, we initially attempted to identify theories that could be used to explain culture and social relationship in a quantitative manner. We then looked at two cultures and extracted statistical information with regard to two different kinds of social relationship. The statistical information was then assimilated with existing culture and social relationship theories where we employed a parameterized socio-cultural model, which estimated proper posture based on culture and social relationships. This model thereby provides a means of identifying the non-verbal attributes for any culture or social relationship.

In future work, we intend to employ this model in our distance-learning system on the web where two users from different countries can log on to the service and teach their own language to a partner, as well as learn a foreign language from another person. This system will thereby enable users to experience exchanges by employing cultural specific postures through exploiting a human-computer interaction. In creating such a facility, it will also, however, be necessary to evaluate how people perceive the postures generated by our model in terms of naturalness.

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