Addressing the Interplay of Culture and Affect in HCI: An Ontological Approach

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Abstract. Culture and affect are closely tied domains that have been considered separately in HCI until now. After carefully reviewing research done in each of those domains, a formal ontology engineering approach brings us to identify and structure useful concepts for considering their interplay.

Keywords: Affective Computing, Cultural Computing, Ontology Engineering, Awareness, Adaptation.

1   Introduction

At first sight, computers can be seen as "cold" agents from which cultural and affective awareness are absent by default. More than a decade ago, the ground breaking work of Picard [21] helped establish affective computing as a field of research and, more recently enhancing cultural awareness of computer systems has gained some interest [2, 4, 12, 23].

Specific issues are pertinent to the study of affect and culture. One of the most notable problems is the relative dependency of both topics to folk language, which is subjective and relatively fuzzy by nature. Furthermore, both culture and affect are discussed within a range of scientific disciplines (psychology, anthropology, management, sociology, philosophy), each of them having a specific approach to research and each has a specific corpus of definitions. Without a shared corpus of definitions, interdisciplinary comparisons are limited, thus limiting the application of research findings from one discipline to the next one.

Formal ontology engineering aims at defining domains by stressing the internal structure of its related concepts (i.e. determining what their essential parts and properties are; semantic labelling being secondary) as well as inter-concepts relationships. Practically speaking, formal ontologies are concept graphs (each node being a concept) [18] whose concepts' structures refer as much as possible to their philosophical (i.e. objective) nature [30]. While strengthening interoperability of a domain by providing a coherent core of interrelated and well-structured concepts,

ontological representations are frequently used as a powerful means of enhancing domain awareness within computer systems.

In order to promote the quality of cultural and affective human-computer interactions, we aim at developing artificial awareness for both those elements through formal ontology engineering. At first sight, cultural and affective awareness might seem distinct, affective phenomena occurring at the individual level whereas cultures emerging from a group of persons. However, there is no doubt that culture influences an individuals' self-regulation, as well as affects are important in human social processes. Indeed, affect and culture are inherent intertwined elements of human interactions, thus influencing many aspects of human behaviours, communication, and social practices among other things.

In this paper, we present our research for ontologically modelling the interplay between cultural and affective domains. Developing a good ontology requires a clear understanding of it. We report on previously developed frameworks in order to ensure that existing data can be adapted to the resulting work. In section two, we establish how the cultural and the affective domains are closely intertwined, and in section three, we discuss major existing approaches to represent culture and affect. Finally, in section four, after giving a brief review of previous research analyzing the structure of the affective and cultural domains, we introduce our work by focusing on description of basic concepts held at the intersection of both these domains.

2   Affect and Culture as Intertwined Domains

Culture has a strong influence on affective experiences. Mesquita and her colleagues [17] concluded in their review of literature that it has been "*convincingly demonstrated that there are cultural differences in the ecology of emotions*". In their review, they reported that affective antecedents (events or objects that trigger an affective phenomena), subjective experiences (feelings), appraisals, behavioural responses, and even physiological changes related to an affective experience, may vary across cultures [17]. Research also demonstrated that, depending on their cultural origins, people may be more likely to report positive or negative affects, valence of affect itself being subject to cultural variations [29]. Furthermore, processes pertaining to emotion recall are also culturally-sensitive, suggesting that cultural bias might be inherent to the post-hoc conscious assessment of affect [24, 29].

Similarly, cultural experiences frequently produce affective reactions. Thus, one of the aims of research on cultural management is to lower risks of misunderstandings or bad communication that could lead to negative affective reactions [10, 11]. Indeed, stereotypes or use of cultural information in an erroneous manner may trigger negative affective reactions within foreigners, going from revolt and pride, to disgust, cynical amusement or even aggressiveness. When a speaker faces uncommon cultural elements without the resource to correctly understand and/or manipulate them, he or she can respectively experience similar affective reactions. On the other hand, manifesting intercultural awareness and competences can enhance the trust of foreigners, thus strengthening the ethos (credibility) of a speaker. In a general way, the ability to successfully endorse cultural practices, particularly communication and

traditional norms, as well as efficiently manipulating cultural references frequently results in positive attitudes towards the speaker [10, 11]. For the latter it can also be a source of positive self-worth, pride, and personal satisfaction.

Finally, the current affective state of an individual, as well as his or her cultural profile, are both closely tied to the cognitive domain by influencing memory load and impacting on several cognitive processes such as decision making or interpretation of the surrounding world (context sensitiveness). Self regulation and motivational processes can also be affected and then alter behavioural management. Indeed, as mentioned previously, it is well known that affective phenomena developing through the cultural interpretation of a context can trigger culturally-variable communication practices and body languages that, in their turn, could nurture cognitive and affective reactions of other interacting agents. Furthermore, members of a same cultural group have great chances to endorse similar cognitive conceptions of world elements [26] that sometimes include a culture-specific affective charge.

3   Representing Affective and Cultural Domains

Affective and cultural experiences can greatly differ. Affect mainly refers to intra-individual elements whereas culture pertains to between-group and within group (social) situations as well as intra-individual elements. However, as it has just been shown, several similarities and interplays exist between these domains, Thus it is not surprising that research in each of those domains has led to the development of sensibly similar techniques, i.e. dimensional and categorical approaches, for capturing their complexity. Some of them are reviewed in the next part.

3.1   Dimensional Representation

The aim of dimensional representation methods is to reduce a complex domain to a limited set of independent dimensions expressing the major content of the domain.

In the affective domain, recent research has frequently referred to the valence – arousal system [25], with valence going from positive (or pleasant) to negative (or unpleasant), and arousal going from low to high levels in order to describe the suitability and the intensity of affective phenomena. However, several other multidimensional models have been proposed. Fontaine and his colleagues [8] have suggested a four dimensional model including the following dimensions: evaluation-pleasantness (similar to valence), appraisal of control (on the surrounding environment), appraisal of novelty (related to surprise), and activation-arousal. However, determining the correct number of dimensions to perfectly report affective experiences remains an open question.

National systems of values have emerged as an important method to address the complexity of cultures within the last three decades. They are aimed at reporting tendencies that are likely to be endorsed by members of such nations. Hofstede's system of national values was the first, and still popular, of such frameworks [10]. The five bipolar dimensions that Geert Hofstede identified are *Power Distance, Individualism, Uncertainty Avoidance, Masculinity, and Long Term Orientation* (see

[10] for a full definition of each of those dimensions). Despite the very large number of studies that have endorsed the latter approach to discuss cultural issues in several domains [14], there is a long history of debate on the pros and cons of Hofstede's work [16]. One major criticism is that such group-based analyses could not be applied at the individual level [16]. Several other dimensional systems exist that directly include distinct, however related, group and individual levels [11, 28].

3.2   Categorical Representation

Categorical methods focus on establishing a list of clusters (or categories) that are independent from each other. An element is thus discriminated according to its membership to a cluster. Specific properties are sometimes enounced for each cluster and provide additional information to help compare instances of various categories, or to understand their effect. Categories are often established by determining threshold in frequently used dimensions.

When discussing famous categorical methods for affect discrimination, one can mention lists of basic emotions [7], or distinctions between positive and negative emotions. Researchers also distinguish various affective phenomena, moods and emotions being discussed most frequently [15, 27].

Cultural discrimination is sometimes made according to geographical locations (western, middle-eastern, eastern; European, Asian, American, African), historical or dominant belief system (Christian, Muslim, Atheist), socially dominant attitudes (collectivist vs. individualist; traditionalist vs. modern), race or ethnicity (black, caucasian, asian, african). Nations are probably the most currently used cultural categories [10, 11]. Blending several of these categories is also a common practice (afro-American, asian American…) to analyse supposedly more cohesive groups.

4   Formalizing the Interplay of Culture and Affect through Formal Ontology Engineering

Previously presented approaches mainly focus on developing representations to allow comparisons between affective or cultural elements. However, as mentioned, the dependency of those methods to folk language and its inherent fuzziness, raise risks of personal interpretation, misconception or overgeneralization, thus making objective comparisons difficult. Several scholars have already tried to bypass this issue by addressing the structural nature of affect and culture through meta-analysis techniques. Some of this research was of particular importance for our project and is introduced in the next section.

4.1   Previous Structural Analyses

Recently, Klaus Scherer produced a framework of the affect domain that shares a lot of concerns with ontology engineering [27]. Scherer's framework is interesting for our project, first, because it tries to consider all already identified aspects of affective experiences (i.e. their cognitive, neuro-physiological and behavioural dimensions). Following this, six different affective processes, sometimes confused in folk

language, are clearly discriminated from each others, and described as multi-component processes that affect various physiological, cognitive, and behavioural subsystems (table 1). Furthermore, several design features are also identified, whose variations distinguish the different kinds of affective processes (i.e. *event focus*, *appraisal driven*, *response synchronization*, *rapidity of change*, *behavioural impact*, *intensity*, *duration).* The importance of each of the latter features to identify the different kinds of affective processes is also clearly established [27]. Regarding the specific affective process of emotion, Scherer emphasizes its distinction with "feeling", an emotion being *"the total multimodal component process*", whereas a feeling should be seen as *"a single component* [of any affective process] *denoting the subjective experience process".* Scherer also disambiguates aesthetic emotions, *"produced by the appreciation of the intrinsic qualities of the beauty of nature, or the qualities of a work of art or an artistic performance*", from utilitarian emotions, *"facilitating our adaptation to events that have important consequences on well-being*". Basic emotions generally refer to the latter category.

Table 1. Scherer's list of affective processes and their related descriptions

Affective Process	Definition
Emotions	- *"An episode of interrelated, synchronized changes in the states of all or most of the five organismic subsystems in response to the evaluation of an external or internal stimulus event as relevant to major concerns of the organism"*
Moods	- *"Diffuse affect states, characterized by a relative enduring predominance of certain types of subjective feelings that affect the experience and behavior of a person";* - *"Often emerge without apparent causes";* - *"Generally of low intensity"*
Preferences	- *"Relatively stable evaluative judgments in the sense of liking or disliking a stimulus, or preferring it or not over other objects or stimuli"*
Attitudes	- *"Relatively enduring beliefs and predispositions towards specific objects"* - *"Can be labeled with terms such as hating, valuing or desiring"*
Affect dispositions	- *"Tendency of a person to experience certain moods more frequently or to be prone to react with certain types of emotions"*
Interpersonal Stance	- *"Affective style that spontaneously develop, or is strategically employed in the interaction with the person or a group of persons"* - *"Examples: being polite, distant, cold, warm, supportive, contemptuous"* - *"Often triggered by events (encounter of a person), but less shaped by spontaneous appraisal than by affect dispositions, interpersonal attitudes, and most importantly strategic intentions".*

Several studies inform us about the structure of cultural elements. In cross-cultural psychology, Kashima [13] found that scholars identify a culture as a "*a process of production and reproduction of meanings in particular actors' concrete practices (or actions or activities) in particular contexts in time and space*". or as a "*relatively stable system of shared meanings, a repository of meaningful symbols, which provides structure to experience*". Dawkins [6] popularized a vision of culture and its evolution inspired by genetics, where memes (i.e. cultural elements) are transmitted through individuals. If a meme provides social advantages to its owner, then he is more likely to be transmitted

and to become a genuine part of a culture. Several other scholars [9], have extensively discussed the interest and limitation of this approach, particularly in its mental (cognitive) dimension [22]. UNESCO is also a natural source of information for cultural comprehension, and defines culture as "*The set of distinctive spiritual, material, intellectual and emotional features of society or a social group, [...] it encompasses, in addition to art and literature, lifestyles, ways of living together, value systems, traditions and beliefs*" [32]. Representing cultural heritage, tangible or intangible, is also an important aspect to consider in our project [2].

Finally, our project is rooted on concepts developed for the YATO upper ontology project [18], that is introduced in the next section.

4.2   Overview of YATO

According to the IEEE Standard Upper Ontology Working Group, an upper ontology "*is limited to concepts that are meta, generic, abstract and philosophical, and therefore are general enough to address (at a high level) a broad range of domain areas. Concepts specific to given domains will not be included; however, this standard will provide a structure and a set of general concepts upon which domain ontologies (e.g. medical, financial, engineering, etc.) could be constructed*".

Following is a short summary of some of YATO's main concepts. **Entity,** "*something which exists independently of others*" is divided into three sub-kinds of concepts**,** the first two of them being common in the ontology literature.

- **abstract** entities are "*things that need neither 3D space nor time to exist*" (such as **truth**).
- **physical** entities (or concrete), are things "*that needs both 3D space and time to exist*". **Physical** has two sub-categories: **occurrent,** that can evolve mainly in the time dimension (such as **process**), and **continuant**, that can evolve mainly in the 3D space (such as **artefact**).
- **semi-abstract** entities are introduced in YATO as things that "*need only time to exist*". **Representation** is an important kind of semi-abstract entity. Indeed, as in philosophy studies, YATO clearly makes a distinction between an element and its representation, described as a "*content-bearing thing*".

YATO also extensively discusses the notions of **quantity** and **quality** among other things. Readers interesting in taking a closer look at YATO can browse it online at [18]. Our own project can be seen as an extension of YATO to deal with cultural issues and is implemented with the same ontology builder tool called HOZO. HOZO is based on a theory of role described in [19]. For instance, depending on the context, an instance of a **human agent** may have, say, a role of a teacher, a nurse, etc. and HOZO allows one to explicitly mention the role of a concept class in its context of use. Any kinds of inter-concept relation can also be defined and used to create cohesive more models of a domain. "Is-a" links are particularly important: they allow to group "families" of concepts (a root concept and its specializations recursively). Internal structure of concepts can also be represented by specifying its essential part (p/o) and attributes (a/o) links.

4.3 Basic Concepts at the Interplay of Culture and Affect

As seen in previous sections, there are a lot of domains that may be important for considering the interplay of culture and affect. The structure of the culture concept itself has to be discussed because several of its parts can induce affective experiences. We also need to discuss the identity of an affective experience i.e. what are its essential parts and properties, and what are the different kinds of it. Furthermore, it appears necessary to find a way to describe the context (or situation) of occurrence of these experiences, which is an inherent part of them. Finally, having some conceptualization of the mental (cognitive) world appears to be a prerequisite to any further development since it is the location of much of this interplay.

Cognitive World. Two families of concepts have to be distinguished: mental atoms of information (such as **thoughts** in YATO) and **mental processors** for managing this information. Both concepts have been the subject of intense discussion in the cognitive science domain.

YATO identified top mental processors as **single mind** (related to a **singleton agent**, such as a human being) and **collective mind**, (shared through a **complex agent** such as a **cultural group** or a multi-agent system). We see top mental processors as compositions of several lower level mental processors, whose identity refers to the specific processing task they are in charge of. Until now, we have mainly focused on the **memory processors**, in charge of memory management functions (others processors still have to be described). For a long time, research has divided the latter into three kinds of sub-modules [3]: **sensory memory module** for sensorial information retaining after the end of the sensorial experience, **long term memory module** for long term information storage, and **working memory module** for temporarily storing and manipulating information. The later is particularly interesting in the frame of this paper. It is frequently described as a limited buffer. Intense affective experiences is said to lower the amount of such memory available for cognitive processing. Elements that are culturally uncommon are said to necessitate more working memory than those that are common. Moreover, affective cues are known to facilitate memory recall (i.e. transferring thoughts from long term memory to working memory).

Mental information or **thought** also received a lot of attention from the research community, with two kinds of information frequently mentioned [1]: **declarative memory**, that is fact-like information, and **procedural memory**, that is skills or procedures. **Collective thought** is a concept similar to shared cognition, which has been discussed by the multi-agent research community [20] among others.

All those memory concepts have been much more elaborated since early research, leading to efficient cognitive models such as ACT-R [31] but due to space constraint, we can't present further details in this paper.

Context. The complete genesis of our conceptualization of **centered context** can be found in [5]. For resuming, a **centered context** is objective. It is a *subset (i.e. parts)* of a related world (3D world, social world, political world, cultural world, emotional world) that surrounds a *context center*. For each elicited dimension, **contextual relations** between its *center* and its *parts are enumerated*. **Primitive contexts** are unidimensional contexts (spatial context, temporal context), but contexts of the real world (such as a **cultural context**) are mainly multidimensional. They are called **composite contexts,** and are elicited as an association of primitive and/or lower-level composite contexts. One has to notice that a **composite context** is a context that is more complex than the sum of its parts.

A second kind of context, that we call **mental context**, is subjective and refers to the set of memories that comes to mind when stating a name or a situation (for instance when someone is asked to think about a "medical context"). Such a context depends a lot of personal experience, and is thus highly culturally-sensitive. It can also easily trigger affective reactions.

Affective Experience. Our conceptualization of affective experience strongly refers to Scherer's meta-analysis presented in [27]. An **affective experience** (Figure 1) [1] is a multidimensional process made of a *cognitive dimension*, a *neuro-physiological dimension* and a *subjective dimension* (feelings). Such a process has an *owner* (the agent in which it occurs), and is strongly sensitive to the *context of occurrence*. It will eventually produce a *behavioural response*, which may vary according to its *intensity*. *Intensity* (arousal) itself is related to both cognitive

Fig. 1. Structure of the affective process concept

arousal, and neuro-physiological arousal. The **affective process** can have been triggered by *affective antecedent(s)*, which would be specific parts of its *context of occurrence* (in one or several contextual dimensions).
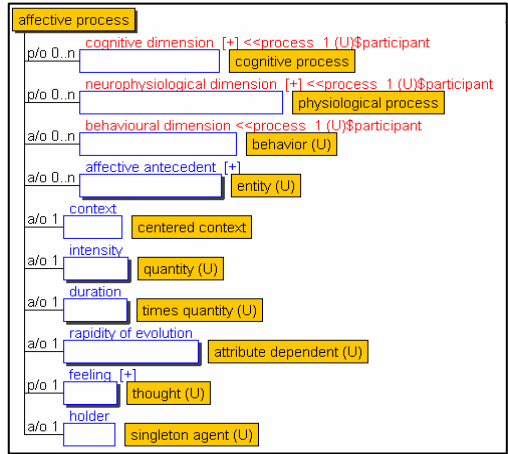
We considered the same list of affective processes as the one defined in Scherer's framework (see table 1). However there are structural distinctions between **mood** and **emotion** (**individual affective modulator** related to individual regulation through physiological and cognitive influence), **attitude** and **interpersonal stances** (**interaction affective modulator**, related to regulation of external interactions), and **preference** and **affect disposition** (**personality informer** that describe the affective dimension of personality). Finally, **blended affective process** describes a multi-component affective experience, whose components (i.e. affective process) cannot be considered individually.

Fig. 2. Structure of the **culture** concept

Culture. Culture's identity (Figure 2) refers to cultural elements that the *owner of the culture* (its related cultural group) has produced or endorsed (through historical processes such as conquests). Such elements can
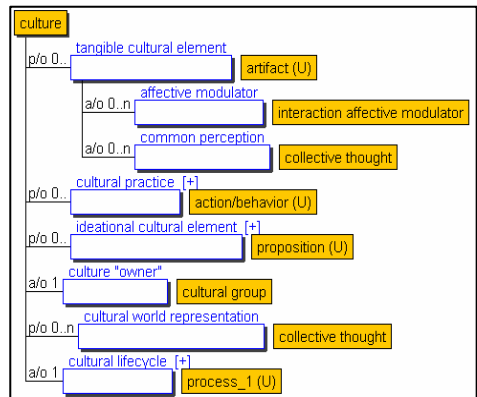
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[1] In figures 1 and 2, the *(U)* symbol indicates concepts already elicited in YATO.

be *artefacts*, *practices* (such as rituals, language, or common behaviours), or *ideational elements* (such as norms, scientific knowledge or beliefs). Interactions of members of the cultural group with any of these elements can be characterized by *affective reactions*. Same members can also share *perceptions* of such elements that may be unknown to foreigners, and *original representations of the world*, that are not specifically related to reality (such as stereotypes). Because they are difficult to understand by a foreigner, such representations may lead to misinterpretations and trigger affective reactions.

5   Conclusion and Future Work

In this paper, we have explored the interplay between culture and affect. We have introduced our reflection on important elements to be considered when addressing this interplay as a part of our long-term project of developing a formal ontology for allowing artificial cultural awareness. The concepts we are structuring are also useful information for those interested in affective computing.

The work presented here could guide the development of data structures to manipulate cultural and/or affective concepts. It could also inform the development of new cognitive models for enhancing learner representation, as well as the design of more realistic autonomous agents.

Developing a formal ontology is a long journey. It is only through discussions, corrections and agreements with other scholars; and through subsequent successful developments of several culturally and/or emotionally-aware systems that we will be able to consider our project as stabilized.

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