

Emotions in human-computer interaction: the role of nonverbal behavior in interactive systems

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Until recently, the area of human-computer interaction was based on a traditional, cognitive approach, which separated the study of usability from that of emotions. The recent research has shown that emotions play an important role in our life, which led to focusing on the need of studying the emotions in the domain of interactive design. This paper underlines the role of emotions as part of the interactive human-computer process, reinstating the importance of nonverbal communication in this domain. The main issues of this paper are concerned with aspects such as: emotional design approach, the importance of nonverbal as an instrument of usability evaluation and the role of emotions in human-computer interaction.

Keywords: *Emotional design approach, nonverbal communication, emotions, usability, Human-Computer Interaction (HCI).*

Introduction

Recently, human-computer interaction has suffered several changes due to the reorientation beyond efficiency, by highlighting a new objective: understanding the way people perceive technology and experience it.

From this point of view, M. Hassenzahl and N. Tractinsky (2006) show the importance of two constructs: *non-instrumental quality dimensions* and *emotional quality dimensions*. The non-instrumental quality dimensions can be described as quality aspects concerned with users' requests that go beyond tasks, objectives and their efficient accomplishment.

The role of emotions is essential to understanding user's behavior when faced to different application programs. Without neglecting the particular constructs of informatics, such as usability, we can not disregard those of affects, emotions, satisfaction when relating to human-computer interaction domain.

Although till now such constructs have been taken into account when facing the interaction with specific applications such as computer games, we should not disregard their importance in other categories of interactive systems.

The emotional aspects play an important role in the inclusive systems based on integrating the persons with disabilities. In this kind of approach two important aspects must be considered: 1. to establish the special educational

requests taking into account the emotional aspect and 2. to carry off the existing differences through universal design. The special educational requests are those particular needs towards education (derived or not from an inadequacy), supplementary or complementary to general education objectives of each person. If these requests are not dealt in a proper manner the scholar, professional and social participation/integration will not be equalized. Sometimes the persons with disabilities face different problems when trying to access the new technologies and services, because some barriers are raised by the information society itself.

The accessibility problems can be overcome through universal design and development of assistive technologies. E-accessibility offers this possibility to all users of information society, even to those with disability problems. For this, the systems used to integrate the persons with disabilities should be based on the universal design that's able to deal with the existing differences among people. It also contributes to improving the self image, because we should be aware of the fact that the persons with disabilities have a poor self image and a low feeling of self. Having a poor notion of self image is reflected in the array of experienced emotions: negative evaluation of the corporal scheme and of self image, feelings of inferiority, anxiety and depres-

sion, mistrust, passive attitudes of aggressiveness and impulsiveness (emotional and social self isolation).

Through universal design the differences among people can be trimmed down, making them less seeable and less discriminating.

The aim of this paper is to present the theoretical aspects that must be taken into consideration when studying the human-computer interaction. If early research focused on a cognitive approach, the recent research has shown that there is no need to set up a stiff delimitation between cognition and emotions when we study the human-computer interaction. Due to the existing contention concerning this aspect, we have shown the importance of both approaches, choosing a middle way that is appropriate to the study of the human-computer interaction.

As we have shown along the paper, the importance of the psychological aspect of emotions in the domain of human-computer interaction can lead to solving some important aspects concerning the design of interactive systems.

1. Emotional quality design

The utilitarian and hedonic dimension of evaluation has become one of the essential aspects in the study of usability due to the interdependence between decision making and usability. Up to now the approaches of interactive evaluation systems have focused on the tasks and the objectives, on their efficient acquisition, and also on processing the cognitive information implied by this process.

Patrick W. Jordan (2000) draws attention on the need of a hierarchical organization of users' needs focusing not only on functionality and usability, but also on aspects regarding the user's satisfaction during the interaction. Over the last years the studies have been focused on the non-instrumental quality dimensions, like hedonic qualities or visual aesthetics. Affective/emotional components can be, on one hand, immediate, unmediated affective reactions and, on the other hand, more complex emotional consequences that result from a cognitive appraisal process.

In 2004, D.A. Norman introduces the concept

of emotional design, and in the same year P. Desmet and P. Hekkert presented a model of emotions regarding the individual's perceptions towards a product. One year later, P. Zhang and N. Li (2005) studied the concept of affective quality to which they refer as "the ability of interactive systems to generate changes in the user's affective behavior". This is the reason why the aspect of non-instrumental quality and the role of emotions have been studied individually in order to be better understood. For evaluating the interactive systems, considering user's experience as a whole, the aspects we have mentioned earlier must be integrated in a model. In this manner we understand user's experience we can also compare his experience when interacting with different systems.

When discussing the emotional design quality a question arises: "Which is the connection between emotions and design?" Emotion is one of the strongest differentiators in user experience namely because it triggers unconscious responses to a product, website, environment or interface. Our feelings strongly influence our perceptions and often frame how we think or how we refer to our experiences at a later date. When it all comes down to emotional design and usability, most of the time we think of drawing in user's attention. This includes designing to minimize the common emotions related to poor usability such as frustration, annoyance, anger and confusion.

Considering what we have mentioned earlier, we can extend the issue towards the emotional persuasion through the type of the chosen design. We can take into account the marketing vision: designing an interactive system represents a product itself, a product whose attributes have as target the final consumer: the user. For assuring the product's (in our case, the designed system) success we must focus on the conditions it has to fulfill in order to be placed in the user's acceptance zone. So, taking into consideration the type of design, we can influence the user's emotions on specific channels, which lead to emotional persuasion.

For better understanding we propose some

short examples that show different contexts of design that complete the emotional persuasion. *Websites design*: a well organized website with a professional, "clean look and feel", with intuitive navigation and task-oriented functionality influences the following emotional reactions: perception of credibility, trust, perception of security, perceived ease of use (F. Spiller, 2004). *For a software application*: a software application that is task-centric, contains "just in time" features and performs robustly influences the following emotional reactions: user's satisfaction, perceived software quality, Subjective judgment or product "appealingness" (the hedonic quality). In the case of *a product or device*: a product that carries aesthetic value and performs elegantly can influence the following emotional reactions: attachment or bond with the product, the perception of performance, perception of pleasure (F. Spiller, 2004).

The last aspect refers to *a physical environment*: environments that facilitate the needs of social, physical and group dynamics with aesthetic considerations can have the following emotional reactions: loyalty behavior and productivity increases.

Some may say that a limitation concerning this subject is the universality of emotions. It is true that when dealing with the study of emotions one might stumble upon the issue of universality of emotions. It is known that user's cultural belongings influence the evaluation of emotions due to the variable aspect of emotion display (Orient vs. Occident). I find this problem not so disturbing because in Informatics, the usability problems that appear come down to a concrete aspect, and, therefore, we expect clear reactions from users, such as verbalizing or writing the shortcomings. The accent is upon users' objectives, their attitudes and expectations towards the products, an aspect that is responsible for varying emotional intensity.

2. The Nonverbal: an instrument of usability evaluation

The nonverbal communication, through facial expressions, plays an important role in the human-computer interaction, pointing out

the usability problems that user might stumble upon.

Up until now the research has focused on pointing out the negative emotions through monitoring the nervous system, an important aspect being recording the blood pressure, the skin conductivity, the rate of breathing, considered to be important psychological signals that underline a change in individual's behavior (R.W. Picard, 2001). R.D. Ward, P.H. Marsden, B. Cahill and C. Johnson (2001) have tested through skin conductivity the emotional reactions in the case of human-computer interaction.

The facial expressions were first studied by Charles Darwin, who in 1872 published the well-known book *The expression of the emotions in man and animals*. This was the beginning of a real controversy concerning the exposed theory, because starting with 1930 the thesis of universality of emotions began to be a contested territory. The first author to do that was Otto Klineberg that postulates that the theory of universality of facial expressions should be submitted to cultural determination.

Regarding his opinion Otto Klineberg takes as example the different significations of smile across cultures: Orient versus Occident. While for Europeans the smile might be the sign of happiness, pleasure or irony, for Japanese people it could simply imply their agreement with the applied punishment or could be the sign of indignation associated with the person applying the punishment (S. Chelcea, 2005, 58).

In 1965 is Paul Ekman's turn to study the facial expressions and to launch his own hypothesis concerning how these can be displayed and recognized. Paul Ekman starts from the hypothesis that facial expressions are programmed as a natural side of emotions, each emotion being assigned with two facial expressions: one that is hereditary programmed and therefore is the same across all cultures, the other being perceived as different according to the culture involved.

Paul Ekman points out in an article written in 1994 that persons belonging to different cultures have the same facial expressions in

some particular situations. The question that arose from these observations was if there are facial expressions of emotions without these emotions being felt (P. Ekman, 1994). When someone displays a false facial expression his face does not betray this, more than that, some have the capacity to draw others' attention making them believe that an emotion is felt, when in reality is not. Facial expressions that are false can be separated from those really felt by taking into account the lack of activity of some facial muscles. Although false expressions are intended to mislead another person into thinking an emotion is felt when it is not, referential expressions are not intended to deceive. Referential expressions are intended to communicate that the emotion referred to is not being felt at the moment of expression. These expressions most often occur when people talk about past or future emotional experiences, describing feelings not now being felt. In such accounts, sometimes the emotion referred to is shown by a referential expression; it may be the only reference to the emotion, without any verbal label.

The reliable muscles should not be evident in referential expressions. Although a referential expression must resemble sufficiently an actual emotional expression, in order to know which emotion it refers to, it must differ sufficiently for the observer to know that the emotion is not felt at the moment of expression. This can be observed by taking into account the duration of the expression which usually is very short or very long, or can start or end abruptly comparing to the real expression.

To distinguish a voluntary facial expression from an involuntary one, excepting micro expressions, we have to take into account the following characteristics:

1. *Morphology*. This is best documented for enjoyment; but the absence of any of the reliable movements should raise questions about whether the expression is voluntary rather than involuntary, and the presence of the reliable actions should suggest that an expression is genuine.

2. *Symmetry*. While tedious to measure, and

not likely to be detectable in real time, asymmetry is a mark that the expression is deliberate.

3. *Duration*. Very brief ($< \frac{1}{2}$ s) and very long (> 5 s) duration of expression should occur more often with deliberate than spontaneous expressions.

4. *Speed of onset*. Although this varies with social circumstances, the onset of a deliberate expression will more often be abrupt than that of a spontaneous expression.

5. *Apex overlap*. In those expressions in which there are multiple independent facial actions, it is likely that the apexes of the actions will overlap if the expression is spontaneous. There has been no research on this suggestion.

6. *Ballistic trajectory*. The expression will appear smooth over its trajectory, without a stepped or jagged offset, if it is spontaneous.

7. *Cohesion*. The expression will fit with what is being said simultaneously. (P. Ekman, 1999, 15).

Based on the research conducted, Paul Ekman draws the conclusion that facial expressions of emotions are universal and cultural specific.

R. Hazlett (2003) made an experiment in which he identified user's facial expressions while accomplishing a task on a website. The research used electromyography as technique.

Within an interactive human-computer context the following aspects must be taken into consideration: emotions, physiologic activation, facial expressions, cognitive evaluation, behavioral tendencies, and electromyography (to analyze deeper the facial expressions and to establish if there are some behavioral tendencies or not). Combining these aspects within methodological investigation leads to evaluating different emotional reactions, and, therefore a basis for analyzing the emotions during human-computer interaction is created.

3. Emotions and human-computer interaction

At the beginning the cognitive approach was the basis of human-computer interaction,

which leads to setting an inflexible delimitation between cognitive and emotional functions. Recent work has shown that another approach was needed: one oriented towards the study of emotions during the human-computer interaction.

Recent research, especially in the field of neurosciences, pointed out the primordial role of affects over the rationality concerning both the evolution of brain and also its function in real time. Even more, the lab experiments have shown that information processing in the neocortex is slower than processing it with the emotional brain. Also, the number of connections from the limbic system to the neocortex is larger than the number of connections that start from the rational brain (neocortex) and head towards the emotional one (the limbic system) (S. Chelcea, 2008, 366). These being said we should not jump to the conclusion that the functionality of the emotional brain is independent from the rational one, or vice versa. Instead of judging in terms of opposition between rational and emotional, we should point out that emotions are indispensable for human knowledge and explaining the human behavior and their interaction exclusively on terms of rational or emotional elements is not possible. A middle way must be taken into consideration.

The basic emotions are: happiness, surprise, fear, anger, disgust and sadness, "those emotions that in some circumstances can be associated with facial expressions" (Adolphs *apud* S. Chelcea, 2008, 368).

In comparison to basic emotions the cognitive ones have a higher degree of evaluation because they are not reflex reactions; they vary from one culture to another, from one individual to another. Guilt, shame, embarrassment, jealousy are an example of cognitive/social emotions. These kinds of emotions play an important role in adjusting the social behaviors.

Compared to basic emotions such as happiness, fear, anger, sadness, surprise and disgust, some emotions are learnt, because they appear only when the individual is exposed to models belonging to a specific culture.

Lev Vygotsky (1962) and Joseph Ledoux (1994) considered that the separation between emotions and cognition was a good choice neither in psychology nor among the cognitive sciences. In 2002, Jeremy R. Gray *et al.* showed that emotions and cognition play a balanced role in controlling thoughts and behaviors. Therefore, emotions and cognition are mutual regarding their action: emotions contribute to behavior and thought adjustment and cognition contributes to adjusting emotions.

The domain of artificial intelligence concurs with this paradigm of integrating emotions with cognition. So, studying emotions by measuring the facial expressions in human-computer interaction offers the chance of identifying the difficulties that users stumble upon. A conclusive example in this case is the video recordings made while the users test different products. The video recordings are concerned with recording the facial activity, the facial expressions which could lead to an easier recognition of the difficulties that users stumble upon. It is true that this kind of systems can not identify the source of these difficulties during human-computer interaction, but once the difficulties have been detected the users can be interview in order to identify the elements responsible for the inconveniences.

Conclusions

More recently changes have been made regarding the use of internet and the interaction with the information and communication technologies. These changes can be seen in the way people communicate and interact with one another. Concerning this point of view, the subject of online communities and their social impact due to new ways of sharing and transmitting the information might be an interesting approach. The celerity of technology spreading and accessibility raises the issue of usability and accessibility, an issue that concerns users around the world (including persons with disabilities).

The new technologies represent a transition towards the new forms of society based on creation and information/knowledge ex-

change. The continuous changes leave their marks not only upon human-computer interaction, but also upon the human behavior, upon the collective consciousness and upon the social-economic environment. The development of information society contributes to increasing the likelihood of confronting with accessibility problems. And there is more to it than meets the eye: the social and cultural infrastructure that acts as a support to the socio-economic environment can no longer measure up to the new aspects of knowledge society (The Council of Europe, 2002).

In present, the existence of a universally inclusive information society represents not only an objective but a global requirement that must be based on the following aspects: 1. the characteristics of the target-population (including the persons with disabilities); 2. the objective and the typology of tasks; 3. the different contexts of usage and their effects (I. Basdekis *et al.*, 2005). A lot of people are skeptic when it comes down to new technologies, putting the blame on a new form of discrimination due to accessibility (The Council of Europe, 2002). Regarding these aspects we agree that there are enough objectives to be accomplished so that the deprived groups could benefit from the information society.

Any complex interface once launched on the market faces a few problems concerning usability. These problems are responsible for the emotional reactions such as frustration or annoyance on the behalf of the users. In order to prevent these inconveniences we have proposed the nonverbal as an instrument of usability evaluation when referring to human-computer interaction. Video recording of disappointment as facial activity when the users were not aware of their emotional reaction and focus groups helps the design of interactive systems by reducing the number of possible errors. We live in a consumer society based on exchange. Because the positive or negative emotions induced by a product influence the need for consumption, the need of having a special product, measuring the emotional expression could be a crucial element in understanding the process of deci-

sion making.

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