# Emotions and EMG measures of facial muscles in interactive contexts

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**ABSTRACT**
In this position paper, we address three topics regarding the use of users' facial expression to study emotion in HCI: theories of emotion as basis for research, EMG measures of facial muscles to study users' emotions and application of emotion recognition methods in user experience studies.

**Keywords**
Emotions, facial expression, EMG, user experience.

**INTRODUCTION**
Emotions in HCI are studied from different perspectives. Mahlke [10] distinguished the affective systems [13] and emotional design approach [11]. Irrespective of the aim of studying emotions in HCI most researchers want to measure emotions in some respects. Many different methods to measure emotional aspects are available and used: ranging from psychophysiological measures as heart rate, EDA pupillometrics or EMG to speech or video analysis and different kinds of survey methods like questionnaires, interviews an so on. From the affective computing perspective, the aim is to find 'non-invasive' methods for adaptive systems by validating these with assessment methods [1]. For studying emotional designs, assessment methods are most commonly used so far, because of their low costs [3]. However, one important question for both approaches is what theories of emotion to choose as a basis for measurement results.

**THEORIES OF EMOTION**
Among the theories for structuring emotions, two main theories are currently established. First, a discrete approach claiming the existence of universal basic emotions [4] and second, a dimensional approach assuming the existence of two or more major dimensions which are able to distinguish between and describe different emotions [14]. There is still a controversy, which approach best captures the structure of emotions, even though attempts have been made to conflate the two [15].

We follow the argumentation of Herbon, Peter, Markert, van der Meer & Voskamp [6] for using dimensional approaches in HCI especially when psychophysiological measures like heart rate, EDA or EMG are used. Otherwise, results of measuring methods that are based on categorical approaches like the facial activation coding system [5] are hard to transfer to dimensional theories of emotion. Nevertheless, we used a dimensional approach in our studies of emotions in HCI using EMG measures.

**EMG MEASURES AND THE STUDY OF EMOTION IN HCI**
In a couple of studies EMG measures were used to study expressive aspects of emotions in HCI [2,12]. Partala & Surakka [12] studied the effects of affective interventions. They recorded facial EMG responses from the *zygomaticus major* and *corrugator supercilii* muscle sites, that control smiling and frowning. Their subjects were exposed to pre-programmed mouse delays in an interactive problem-solving task. Following the mouse delays, three types of conditions were used: positive or negative interventions given via speech synthesizer, and no intervention. They found that smiling activity was significantly higher during the positive than the other conditions. The frowning activity attenuated significantly after the positive interventions than the no intervention condition.

For our study we designed two different simulations of a mobile phone to induce different emotional experiences [8]. One of them was designed usable and the other one had various usability flaws. The use of the first system should lead to more positive and the use of the second one to more negative emotions. We validated both assumptions in a pretest, where we tested the usability of the systems and emotional user reactions using a self-assessment scale [10]. We developed two comparable groups of five different, typical tasks that were used in the experiment, and used EMG measures of the two facial muscles that are associated with positive (*zygomaticus major*) and negative (*corrugator supercili*) emotions to record expressive behavior.

Our results suggest that the frowning activity was significantly higher in the unusable system condition than in the usable system condition. This result supports our hypothesis that more negative emotions are experienced in the unusable system condition. On the other hand, we found higher smiling activity in the unusable system condition; a result that we did not expect. At first view, both results seem contradictory, but also in other studies high activity of the *zygomaticus major* was found in negative emotion conditions [7]. For instance, Lang et al.

[7] found similar results, when they studied expressive reactions to emotionally relevant pictures. Ekman & Friesen [5] suggest the control of another muscle site to differentiate activity of the *zygomaticus major* in positive and negative conditions. Otherwise, these results indicate how difficult it is to base the study of emotions on the interpretation of facial expressions alone.

Another basic conception in emotion psychology, that most of the measurement approaches in HCI do not consider so far, supports this assumption: the idea of a multi component character of emotion. We propose the component approach to emotions by Scherer [16] as one example that describes this basic assumption to better understand which methods are needed to measure emotions in interactive contexts. Scherer [16] defines emotions as consisting of several aspects or components: subjective feeling, physiological activation, motor expression, cognitive appraisal, and behavior intentions. Emotional states can be described as configurations of states of these components. Besides, motor expressions of emotions consists next to facial expressions for example also of speech and body expressions. Concluding, we think that it is sensible to combine the measurement of the components if it is possible in the application domain [9].

## USER EXPERIENCE STUDIES AND EMOTION RECOGNITION

In the application domain we are interested in, it is possible to combine measurement methods to study different components of emotions. Our main application for the recognition of facial expressions in HCI is the study of user's experiences with interactive systems. New approaches to the quality of interactive systems point out that next to traditional aspects like the usefulness and usability of the system, further facets have to be considered to broaden and enrich HCI's narrow, work-related view on interactive product quality. Next to needs that go beyond the instrumental, like stimulation, identification and aesthetics, especially the role of emotions is discussed as important parts of the user's experience. As mentioned before, so far, mostly assessment methods are used. We suppose that a practicable approach that allows to record users' emotional expressions in interactive system evaluations is one step to consider further aspects of emotions.

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