Measuring Multiple Components of Emotions in Interactive Contexts

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Introduction

Most methodological approaches on the meausrment of emotion in HCI fail to account for a central feature of human emotions, i.e., their multi-component character. This feature is emphasized by a number of psychological theories on emotions. For example, Scherer [1] defines emotions as consisting of several aspects or components (Figure 1). The "emotion triad" proposed by Izard [2] resides in the center of the model. It comprises subjective feelings, physiological activation, and motor expressions. This triad is connected to two other components, i.e., cognitive appraisals and behavioral tendencies. The cognitive appraisal is modeled in more detail. It is characterized as a sequence of stimulus evaluations based on five dimensions: intrinsic pleasantness, novelty, goal/need conduciveness, coping potential, and norm/self compatibility. Any emotion is regarded as a specific pattern consisting of cognitive appraisals and the states of the other components.

Research questions

Can the component approach also be used for describing emotions in the context of HCI? To answer that question, we set up an experiment that addressed two issues:

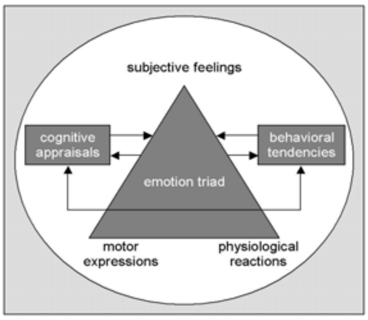

Figure 1: Scherer's component model of emotion

a) which relations exist between the different components of an emotional experience, and

b) which components and methods distinguish between emotional reactions to interactive systems of different quality of use.

An approach to the study of multiple components of emotion in HCI

***Dependent variables*: Several methods were used to gain information on the components defined in Scherer's model. To measure subjective feelings, participants filled in the self-assessment manikin (SAM) by Lang [3]. Heart rate and EDA served as indicators for physiological reactions. To measure motor expressions, EMG data of two facial muscles were used which are associated with positive emotions (*zygomaticus major*) and negative emotions (*corrugator supercili*) [4].**

Figure 2: Experimental setting

With respect to behavioral tendencies, the time required for input operations was recorded since this parameter is of central importance in the context of human-computer interaction. To collect data on cognitive appraisals, participants filled in a short form based on the Geneva appraisal questionnaire [5].

***Study design*: Thirty individuals (half of them women) participated in a study. Two versions of a computer-based simulation of a mobile phone were designed to induce two different degrees of usability. While the "well designed" version was highly usable, the "ill designed" one had several usability flaws. The independent variable of the experiment was the factor "version" consisting of two treatments ("well designed" and "ill designed"). Each participant accomplished one group of tasks with each version.**

***Procedure*: The experiment took about 75 minutes. At the beginning, electrodes for measuring physiological reactions and facial expressions were attached, and baseline values were recorded (Figure 2). The participants started with one version and completed the first group of tasks. Then they switched to the other system to solve the remaining five tasks. Heart rate, EDA and EMG were measured during task completion. After each task, participants filled in the SAM scales. At the end of the experiment, everyone answered the appraisal questionnaire.**

Results and discussion

The results of our experiment support the assumption that a number of different – but related – components determine users' emotional experience during human-computer interaction. The well designed system led to more positive and less arousing subjective feelings (Figure 3). Physiological measures showed lower EDA values and less activity of the *corrugator supercili* when usability was high. As expected, EDA measures correlated positively with the arousal dimension, and the activity of the *corrugator supercili* correlated negatively with the valence dimension of the subjective feeling measures.

Although the emotional patterns we detected are rather coherent and consistent, not all methods seem to be adequate for distinguishing between different emotions during human-computer interaction. Based on this approach, we propose to measure the different components of a user's emotional experience by a combination of self assessment ratings, physiological and expression measures as well as cognitive appraisal questionnaires. Although our results must be seen as preliminary, this combination seems to offer a sound methodological basis for future experimental studies on emotions in the context of HCI.

component & dependent variable	M (SD) for well-designed version	M (SD) for ill-designed version
subjective feelings		
SAM – valence (1-9)**	6.6 (1.2)	3.8 (1.7)
SAM – arousal (1-9)**	4.1 (1.5)	5.4 (1.5)
physiological reactions		
EDA [µS]*	2.1 (1.9)	2.5 (2.0)
heart rate [bpm]	1.9 (5.2)	2.2 (5.9)
motor expressions		
*corrugator supercilii**	49.0 (4.4)	52.0 (3.5)
*zygomaticus major***	47.6 (3.6)	51.6 (4.1)
cognitive appraisals		
pleasentness (1-5)**	3.8 (0.8)	2.1 (0.7)
novelty (1-5)**	1.6 (0.7)	2.7 (1.1)
goal relevance (1-5)**	3.6 (1.1)	1.8 (0.7)
coping potential (1-5)**	3.9 (0.8)	2.2 (0.7)
norm/self compatibility (1-5)**	0.4 (0.8)	2.5 (0.9)
behavior intention		
time per input [sec]**	1.7 (0.4)	3.1 (1.2)

Figure 3: Mean values and standard deviation for all dependent variables and both conditions (* $p<0.05$; ** $p<0.01$)

[1] Scherer, K.R. (1984). On the nature and function of emotion: A component process approach. In K.R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 293-317). Hillsdale, NJ: Erlbaum.

[2] Izard, C. E. (1977). Human Emotions. New York: Plenum Press.

[3] Lang, P. J. (1980). Behavioral treatment and bio-behavioral asessment: Computer applications. In J. B. Sidowski, H. Johnson & T. A. Williams (Eds.), *Technology in Mental Health Care Delivery Systems* (pp. 119-137). Norwood, NJ: Ablex.

[4] Cacioppo, J. T., Petty, R. E., Losch. M. E. & Kim, H. S. (1986). Electromyographic activity over facial muscle regions can differentiate the valence and intensity of affective reactions. *Journal of Personality and Social Psychology*, *50,* 260-268.

[5] Scherer, K. R. (2001). Appraisal considered as a process of multi-level sequential checking. In K. R. Scherer, A. Schorr & T. Johnstone (Eds.), *Appraisal Processes in Emotion: Theory, Methods, Research* (pp. 92-120). New York: Oxford University Press.

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