

Multidimensional Emotional Appraisal Semantic space (MEAs). Analysis of the human emotional signals to an interactive computer

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Abstract

New theories on emotion emphasize the tight boundaries among emotion, motivation and cognition: according to them people are motivated to respond to events differently depending on how they have been appraised. The present study tries to examine what kind of emotional responses the subject is motivated to express while interacting with an artificial agent if he/she believes that this agent is able to understand his/her emotional states. For this purpose different kind of computer games were projected to elicit specific emotional appraisals and two different conditions were used: in one condition the avatar provided a simulated intelligent feedback, while in the second only guided the subject across the different tasks. Multimodal synchronized data were captured. All video tapes were codified frame by frame using The Observer 5.0 and THEME Software. This is an in-progress study and data are still under elaboration. This paper includes initial results of the analysis of non-verbal communicative signals.

1. Introduction

Researchers from several disciplines have turned their attention to emotion and its place in the interaction between human and artificial agents, trying to understand and re-create emotion in the user interface [5] [8]. A particular interest has concerned the implementing and design of interfaces able to recognize the user's emotional state from real-time capturing and processing of sensory modalities input via various media: physiological, facial and vocal signals [6]. This study presents an attempt to define some significant features that can be extracted from the user's expressive behaviour and a model able to describe the dynamic changing of the user's emotions during the computer interaction. We assume that a crucial factor for the interaction with an emotional artificial agent and its effectiveness is the presence of a «communicative agreement». If the user is aware of the artificial agent's ability to understand his emotional signals, he can decide to participate in the interaction exhibiting proper communicative signals.

2. Method

2.1 Participants

A total of 30 university students (20-23 years old) were recruited.

2.2 Stimuli Construction

Three different kinds of computer games were projected to elicit specific emotional reactions. Systematic manipulation of appraisal dimensions (SECS, [9]) was used through the selection of types of game events that were assumed to produce specific appraisals. Specifically, game events were supposed to support four emotional evaluation checks: 1. novelty; 2. hedonic value; 3. goal conduciveness; 4. coping. All games were previously tested on 20 subjects to assess their efficacy.

2.3 Tools

An enabling system was set up to implement experimental sessions. Different kinds of devices were used to record the subject's behaviour (Figure1): 1. two high resolution web cameras: one in front of the subject and one behind him; 2. a high quality microphone to record vocal reports; the BIOPAC System [1] to record physiological signals. All instruments were synchronized.



Figure 1: Experimental situation.

2.4 Procedure

Subjects were asked to use the computer where an avatar guided them across the three different kinds of computer games. All sessions started with 2 minutes of free exploration of a web site for the baseline measure of physiological signals. Total duration was of about 20 minutes. They were divided into two different groups, according to the kind of information received by the avatar. In the experimental condition, the subjects were exposed to a simulated emotional-intelligent computer, where the avatar provided a simulated intelligent feedback to the user to decode his emotional state and to adapt the tasks accordingly. The simulated emotional-intelligent computer was actually controlled by an out of sight experimenter. In the control condition the avatar only guided the subjects in the activities. All subjects were alone in the room with the computer. At the end of the computer session, subjects were asked to answer to questionnaire and the Coping Inventory for Stressful Situations [4] [7]. In the questionnaire subjects were asked to assess their own abilities at using a computer; and to judge the efficacy of the interaction with the computer.

2.5 Data analysis and MEAs Method

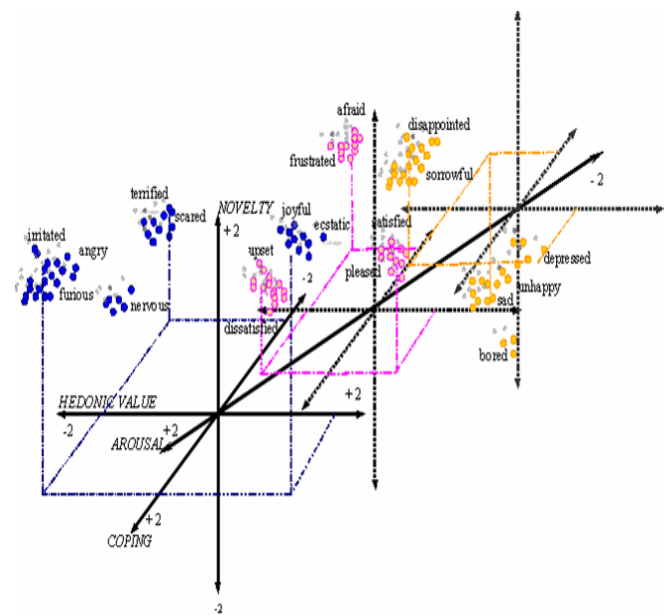
Different kinds of synchronized data were recorded: 1. Physiological signals (ECG, Respiration, Galvanic Skin Response, Skin Temperature); 2. Non Verbal Signals (Posture, Gaze Direction, Facial Movements); 3. Vocal Signals; 4. Verbal Signals. This is an in-progress study and data are still under elaboration. In this study we'll start to present the analysis of non-verbal communicative signals.

At a first level of analysis, a Behavioural Coding System (BCS) was developed to code the subject's interaction. 30 behavioural units subdivided in four categories were mapped (Table 1). Some units were identified by using specific action units (AU) defined by the Facial Action Coding System [3]. Other units for posture, body movements and vocal behaviour were taken from grids used in previous studies on non-verbal behaviour [10]. All video tapes were codified *frame by frame* (25 fps) using The Observer 5.0 NOLDUS Software and THEME 4.0 Software for the recurrent pattern analysis. Facial movements Upper and lower face units were selected. For each unit intensity was rated (Low, Medium, High). Gaze direction To look at the screen, at the keyboard, around, etc. Posture Behavioural units of moving near to /far from the screen were considered Vocal behaviour It was recorded when the subject speaks or uses

other kind of vocalizations (grumbling, no-words, etc)

At a second level of analysis, we used the Multidimensional Emotional Appraisal Semantic space (MEAS) to detect the user's emotional state starting from the analysis of patterns of multimodal signals [2]. MEAS, derived from SECS, analyses the intersection of the four dimensional axes (Figure 2) scored on a 5 point rating scale from -2 to +2 by a group of judges. Inter-judge agreement is calculated (k Cohen).

Figure 2: Dimensional axes.



Results:

This paper includes only initial results (corresponding to the analysis of one subject, 22 minutes and 27 seconds for a total of 26948 frames) which are indicative of the methodology that has been applied.

1. *Analysis of non verbal communicative signals.* Table 1 shows a first statistical output.

Results show that during the interaction with the computer, the subject exhibits communicative

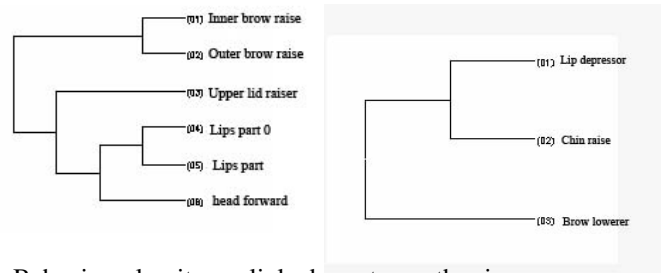
non verbal behaviour. In particular, facial behavioural units are used more frequently than vocal ones and within these facial movements there is a higher exhibition of lower face units (lips).

Table 1: (n) number of total occurrences; (tD) total duration (sec); (mD) mean duration (sec).

	n	tD	mD
<i>Facial movements</i>			
Inner brow raiser	67	20.04	0.30
Outer brow raiser	66	17.92	0.27
Brow lowerer	28	19.52	0.70
Upper lid raiser	26	13.16	0.51
Lid tightener	18	17.04	0.95
Chin raise	71	23.00	0.32
Cheek raise	36	61.32	1.70
Lip corner puller	63	102.16	1.62
Lip corner depressor	43	10.32	0.24
Lips part	99	523.68	5.29
Lip pucker	60	35.28	0.59
Lip pressure	78	52.64	0.67
Lips suck	14	6.68	0.48
<i>Gaze direction</i>			
Look at the screen	29	1296.32	44.70
Look at keyboard	17	10.28	0.60
Look around	8	21.44	2.68
<i>Posture</i>			
forward	22	1245.00	56.59
Head backward	15	87.92	5.86
Head forward	7	27.56	3.94
Initial position	5	41.24	8.25
backward	5	44.12	8.82
Non words (oh, huh)	5	2.32	0.46
puff	2	2.00	1.00
<i>Vocal behaviors</i>			
speech	29	31.88	1.10
laugh	7	5.96	0.85

The analysis of the most recurrent configurations of the emotional expressions show (Theme analysis: number of occurrences: 10; $p < .001$) the presence of patterns of different levels of complexity that involve facial movements, posture, etc. (Figure 3).

Figure 3: T-pattern of expressive behaviours.

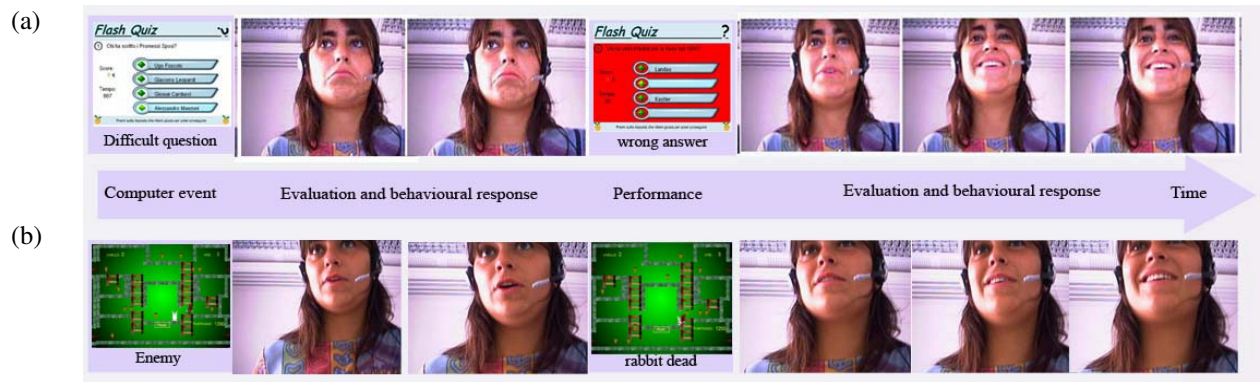


Behavioural units are linked one to another in more complex pattern and expressive configurations. Hence the subject exhibits dynamical facial responses based on the continuous monitoring of the task and performance rather than fixed patterns corresponding to an emotional label.

Another interesting variable to examine concerns the time position of the emotional behavioural response in relation the antecedent (games) Figure 5 shows an example of two *frame by frame* sequences (6.89 sec; 5.32 sec) where the subject is dealing with the quiz game (a) and the enemy game (b). Each sequence starts with the action of the computer and the performance.

computer event (difficult question; enemy): it is followed by its evaluation and a frustration behavioural response which precedes the subject's performance (wrong answer; rabbit dead). Finally the emotional response to the mistake (smile).

Fig. 4: Frame by frame sequences and time structure.



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