The happiness cube paradigm; eliciting happiness through sound, video, light and odor. Assessment of affective state with non-invasive techniques.

Stylianos Giannoulis[1], Dr. Fons Verbeek[1]

[1]Media Technology. Leiden Institute of Advanced Computer Science, Leiden University, Niels Bohrweg 1, 2333 CA, Leiden, the Netherlands
s.giannoulis@umail.leidenuniv.nl , fverbeek@liacs.nl

Abstract. Emotion elicitation and physiological responses are 2 fields that have been studied extensively the last 20 years. Based on the already existing research, a scientific experiment is described with the goal to elicit emotions of happiness to the participants by the use of video, sound and odorants. Contrary to most already existing research, the goal of this experiment is to elicit just one emotion -happiness-. Moreover, the expected multisensory experience is of great significance since most of the existing research on emotion elicitation is usually focusing only on one or two at most sensory modalities.

Keywords: emotion elicitation, happiness, physiological response, biofeedback

1 Introduction

As emotions play a crucial role in normal and abnormal functioning [1], it is not surprising that there is a growing interest and research performed the last 20 years in emotion elicitation and their physiological responses. Several different techniques have been used so far in order to induce certain emotions, including: a) images and sounds b) expressive behavior c) scripted and unscripted social interactions d) music [2] e) smell [3]. Moreover, indoor lightning is proved to have effect on mood and cognition according its luminance levels and color temperature [4].

2 Factors of Happiness

Although emotional response is a complex field of study because of certain characteristics that are not universally of the same volume like : a) the threshold for eliciting components of a particular emotion b) the peak and amplitude of the response c) the rise time to peak and d) recovery time [5]), research from different study fields like: a) Neuroscience [6], [7] b) Psychology [8],[9] c) Social Sciences [10], [11] has already put great effort on discovering what could make people happy, how the brain behaves in certain affective states and what are the physiological responses when experiencing certain emotions [12], [13].

From the perspective of social sciences, research shows that employment, marriage [14], income, education, gender, religion, social life and health [15] have a strong correlation to overall life-satisfaction.

From the neuroscience and endocrinology point of view, it is widely accepted that neurotransmitters like dopamine and serotonin play a great role in our current affective state [16],[17]. Additionally endorphin levels are strongly related with increase in positive affect [18]. Additionally, research showed that norepinephrine levels have great effect on our positive or negative affective state [19].

The smell of lavender is connected with an increase of alpha waves in the brain and consequently it is promoting relaxation [20]. Finally in a experiment performed in laboratory concerning mood elicitation through odorants, vanillin was rated by the participants as the most pleasant [3].

Moreover, there is evidence that placing a patient close to a window with a view outside could speed up the healing of wounds [21].

Listening to music produces changes in the autonomous nervous system which are associated with emotional states. In an experiment conducted by C. L. Krumhansl, [9], it was proved that music has significant effect on our physiological responses compared to the pre-music baserate levels: Cardiac interbeat interval (IBl), pulse transmission time to the finger (FPTT), Pulse transmission time to the ear (EPTT), Systolic blood pressure (SBP), diastolic blood pressure (DBP), and mean arterial pressure (MAP) increased, while Finger pulse amplitude (FPA), respiration intercycle interval (ICI), Respiration depth (RD) and respiration-sinus asynchrony (RSA), skin conductance level (SCL) and temperature on the finger (TEM) decreased. In another experiment [22] music not only managed to induce the desired moods of happiness, sadness and fear but Etzel [22] also agrees with Gabrielson and Lindstrom [23] that fast tempos can be associated with expressions of activity, excitement, happiness, joy, potency, surprise, anger and fear, as it was proven that the music to induce happiness had quick rhythm and melody while music used to induce sadness had much slower tempos.

Moreover from the research done on people's response to different colors, findings show that people describe as quiet and serene colors of short wavelength like blue or green, while colors of long wavelength like red and orange, are described as arousing and hot [24].

Last but not least, one of the most commonly used methods of emotion elicitation is the projection of pictures. This led to the development of the International Affective Picture System (IAPS), a large set of color photographs chosen specifically in order to evoke emotions that include pleasure, arousal, dominance to men and women [25]. The IAPS stimuli are standardized on the basis of ratings of pleasure and arousal experienced by the respondents [26] and experiments conducted in both sexes showed that pictures which include food, sports and adventure, were rated high from both sexes as pleasant and arousing while pictures of babies and nature were rated by both sexes as pleasant but not highly arousing. Men rated pictures of erotic scenes between people of the opposite sex also as highly arousing and pleasant, while women rated these pictures as less arousing and pleasant [26].

3 Methods for Emotion Measurements

The most commonly used non-computer based technique to measure emotional states are self-reports. There are 5 different and dominant affective measures in the mood literature[27]: the Mood Adjective Checklist or MACL, the Profile of Mood States or POMS the original and revised versions of the Multiple Affect Adjective Checklist or MAACL & MAACL-R, the Differential Emotion Scale or DES but it seems that the most commonly used standardized scale is currently the Positive Affective Negative Affective Scale or mostly known as PANAS scale, developed by Watson and Clark [28]. In the PANAS scale, respondents rate to what extend they have experienced each mood on a 5-point scale (1= very slightly or not at all, 5=extremely) in different time periods like: today, past few days, week, past few weeks, year and in general [27].

Although Watson and Clark report extensive reliability and validating data on

the PANAS scales [27], self-report might not be always enough in order to come to safe conclusions as emotions belong to our personal sphere, and respondents have the tendency to present themselves in a socially desirable way if they perceive some topics or questions as threatening [29].

In neuroscience in order to indicate which parts of the brain are stimulated while experiencing specific emotions, Magnetic Resonance Imaging also known as MRI [30], functional Magnetic Resonance Imaging also known as fMRI [31], Positronic Emitting Tomographies also known as PET scans [6] or Electrocephalography also known as EEG [32] have been used in different experiments.

But when it comes to emotions and their physiological responses, sensors that measure: a) skin conductance level, b) heart rate levels c) blood pressure levels d) skin temperature levels e) muscle activity levels are used. The afore mentioned physiological responses can give safe indications of affective state physiological expressions and that's why they are the most commonly targeted responses.

The last 40 years, there is a lot of research concerning emotion and facial expression, which led to the development of a number of observer-based systems of facial expression measurements with the Facial Action Coding System or FACS, developed by Paul Ekman and Wallace Friesen in 1978 [8] being the most commonly used for facial expression recognition. FACS is based on the fact that all people, with a few exceptions of course, have the same facial muscles [33]. In facial actions, various facial muscles are used. Based on that fact and on observers that were capable of distinguishing the appearance changes resulting from the use of various facial muscle, Ekman and Friesen, managed to categorize the facial actions, which are called Action Units, and also describe which facial muscle or muscles are used in each Action Unit. In the new version of FACS, FACS 2002, 66 different Action Units are described [34]. It is important to explain that FACS each self is a system that describes which muscles are used in each Action Unit. It is not a system that describes emotional facial expression but there is a lot of research conducted the last 15 years [35], [36] on computer-based facial recognition of emotion, based on Ekman's FACS.

4 Happiness and Physiological Responses

The research has shown so far that there is no standardized bodily expression of happiness and of emotions in general, which is based on the fact that people experience and express emotions in different intensity [5]. For that reason we can't say so far that when happiness is experienced, there is indication of certain and specific levels of heart beat, skin conductance, blood pressure, respiration, or skin temperature, but physiological response of happiness is described in relation to physiological responses of other emotions like sadness, anger,[12] disgust [6] or fear [22].

5 The Happiness Cube

5.1 Introduction

Based on the afore mentioned scientific research on emotion elicitation and assessment, our goal is to design and construct an installation that would allow the participant to experience happiness in a multisensory way with the use of video, sound, light, smell combined with assessment in a basic level of the user's physiological response and affective state.

We believe that a 20 minute session would be enough to draw safe conclusions

about the effectiveness of our emotion elicitation and assessment hypothesis. This session will be divided in 4 parts: a) self-report, during which the participants are going to fill in a short computer-based questionnaire b) the relaxation part (~7 minute duration) b) the happiness elicitation part (~13 minute duration) c) self report session, during which the participants are going to fill in a very short computer based questionnaire.

5.2 The Questionnaires

The questionnaire will help us assess the participants' current affective state before and after the 20 minute session. We think that filling in a computer-based questionnaire is a better evaluation method than a paper-based method, especially when it comes to disclosure of very personal data like emotions, as it seems that computer administration increases self-disclosure compared to other conventional methods [37].

Both questionnaires should be as short as possible, as emotions are characterized from high intensity but very short duration [38]. For that reason we decided that the first questionnaire shouldn't include more than 15 questions, providing also information about the participants' age, sex, marital status, work satisfaction, health, factors that as mentioned before play an important role in people's affective state [14], [15]. Moreover questions from the PANAS scales are also included, as well as other questions related to well-being and life-satisfaction, like the famous Cantril question, developed by Hadley Cantril in 1965:

> "Here is a picture of a ladder, representing the ladder of life. Suppose we say the top of the ladder (step 10) represents the best possible life for you, and the bottom (step 0) represents the worst possible life for you. Where on the ladder do you feel you personally stand at the present time?"

The questions that provide information about the participants' life-satisfaction and affective state will be rated by the participants in a 5 or a 7 at most point scale, as a 5 or 7 point scale has a clear mid point and there is no significant change in data interpretation, when analyzing the collected data from a bigger than a 9 point scale [39].

The questions that provide information about the participants' current affective state and were used in the questionnaire before the 20 minute affective state, are going to be answered again by the participants after the 20 minute session in order to check if there is a significant change in their current affective state. This questionnaire has to be even shorter as emotions and moods differentiate from each other in duration and intensity. Emotions are experienced in general in a highly intensive way, while moods are characterized by low intensity. Moreover emotions last for a relatively short time compared to moods [38].

5.3 The 7 minute relaxation session

After filling in the first questionnaire, the participants are entering a 2m x 2m x 2m cube. The outer part of the cube will be coated by black fabric in order to create an environment that prevents external factors like daylight to disturb the participant's experience. The goal is to create an environment that will also give the participant the impression of being closer to a more natural environment, as urbanization is growing rapidly all over the world, with a percentage of 49% of the world

population to be urban by 2005, which was expected to rise up to 50% by 2008 and up to almost 60% by 2030 [40] leading to alienation from natural environment. For that reason the inner part of the cube will be coated with green fabric, a color soothing for the eye. And inside the cube green and blue light is going to create an even more relaxing environment.

Lavender odor will be emitted inside the cube, as the smell of lavender is strongly correlated with increase of alpha waves production in the brain, promoting relaxation [20].

Although there is a lot of research already performed on emotion elicitation through music, it seems that the researchers have not come to a final and unanimous conclusion of what kind of musical piece elicits feelings of happiness. Scientists have experimented with different kinds of music [9], [22] and the participants' interest in the music is an important factor for influencing emotional responses [41]. So as taste in music is subjective and what makes one participant happy could probably not elicit the same emotion to other participants, the best solution is to use music that would have an as universal effect as possible. For that reason we think that the best idea is to use natural sounds, based on our hypothesis that urban living is increasing rapidly and people are getting more and more alienated from natural environments.

5.4 The 14 minute happiness session

The session to elicit happy emotions is going to follow after the short relaxation session.

Based on the fact that specific picture content in the International Affective Picture System (IAPS), is eliciting arousal and pleasure in both men and women[26], we are going to project pictures of food, sports, adventures and intimacy between opposite sexes.

Research on emotion elicitation and odorants has shown that participants rated vanillin as the most pleasant odor among the rest [3]. Moreover consumption of chocolate is associated with different neurotransmitter levels in our body, like serotonin, dopamine and endorphins [17]. For this session lavender will be replaced by vanilla and chocolate odors.

Blue and green lighting could still be a good medium to elicit happiness as research in lighting has shown that participants describe blue and green light as pleasant [42],agreeable and relaxing[43].

Natural sounds will still be used and the use of headphones will be able to create a more immersive environment.

5.5 Measuring emotions

There are many different techniques in order to measure emotional changes in subjects and the most common involve: a) self-report b) use of hardware and software that analyze and measure physiological responses. Self-report methods can give indications of emotional changes in subjects, but as respondents could answer questions according to a desirable affective state and not according to their actual affective state, this method of measuring the emotional state of the participants might not be enough.

Moreover, applying sensors to measure heart rate, temperature, blood pressure or skin conductance, might create a feeling of insecurity or even stress to the participants, so it is important to find less invasive methods in order to measure physiological responses. The use of an infrared thermometer to measure body

temperature and a pulse rate ring in order to monitor changes in the participants' heart beat seems currently as an interesting approach for measuring the participants' physiological responses.

Currently, the most dominant idea is to monitor the whole session with a camera and then analyze the participants' facial expressions and responses with software based on the afore mentioned FACS [8], [34]. In that way although the subjects will know that they are going to be monitored, they will not be surrounded by sensors and cables that might be distracting or even create stressful feelings to them.

6 Discussion

The happiness cube is a scientific experiment and it is already under construction and development. The testing is scheduled for the end of August 2009-beginning of September 2009.

From this experiment we hope to get valid results that support our hypothesis about creating an artificial environment that could elicit emotions of happiness with the use of video, sound, light and smell.

The next step could include: a) automation of the multisensory experience b) wireless measurements of physiological responses c) leave the initiative to the user in order for him to train a computer-based program, which understands his physiological responses and could adjust indoor lighting, temperature, available TV channels, music according to the user's current affective state and preferences.

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