Using Portable EEG Devices to Evaluate Emotional Regulation Strategies during Virtual Reality Exposure

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Abstract. As Virtual Reality (VR) is starting to be used to train emotional regulation strategies, it would be interesting to propose objective techniques to monitor the emotional reactions of participants during the virtual experience. In this work, the main goal is to analyze if portable EEG systems are adequate to monitor brain activity changes caused by the emotional regulation strategies applied by the participants. The EEG signals captured from subjects that navigate through a virtual environment designed to induce a negative mood will be compared between three experimental groups that will receive different instructions about the emotional regulation strategies to apply. The study will allow us to validate the possibilities of portable EEG devices to monitor emotional regulation strategies during VR exposure.

Keywords. EEG, Emotional Regulation Strategies, Virtual Reality

Introduction

Virtual Reality (VR) is starting to be applied to train emotional regulation strategies (i.e., [1]). To evaluate if these virtual environments (VE) are achieving their goals, it is fundamental to have instruments to analyze the emotional regulation strategies that each subject applies during the exposure to the VE.

Traditionally, the evaluation of emotional regulation strategies is based on questionnaires, which are used to ask subjects about how they are feeling and managing their emotions [2]. However, there have been other approaches for this purpose that have analyzed physiological responses of subjects that have been exposed to situations with highly emotional content in which different emotional regulations are applied [3]. Other approaches have analyzed brain activity measures such as the electroencephalogram (EEG), which reflects the brain's electrical activity, and in particular postsynaptic potentials in the cerebral cortex. There have been several studies

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which have pointed out the important role of the prefrontal cortex for emotional regulation [4, 5].

Brain activity monitoring using EEG can be easily combined with VE, as long as it does not impose restrictions in the way of presenting stimuli to the subjects of the study. Furthermore, portable devices to capture EEG that have appeared in recent years may even make easier the integration of these monitoring systems in the VR experience.

This fact has generated research that has combined EEG and VR with different purposes. For example, EEG has been used to assess driver cognitive responses in a virtual reality based driving environment [6], to analyze sex differences in brain activity (theta oscillations) associated to navigation in a VR environment [7] and to evaluate the level of presence of participants in virtual reality experiences [8]. However, as can be observed, these studies were not focused on the field of emotional regulation.

In the present work, the possibilities of EEG monitoring to evaluate emotional regulation techniques of participants of VR experiences will be analyzed, focusing on a specific kind of EEG monitoring systems: portable EEG systems. The goal is to analyze if portable EEG systems are adequate to monitor brain activity changes caused by the emotional regulation strategies applied by participants of VR experiences.

1. Method

Thirty subjects will participate in the study. They will be university students without any psychological disorder. In the experimental session, they will navigate through a VE designed to induce them a negative mood (sadness). Some pictures of the used VE are shown in Fig. 1.

Figure 1. Captures of the virtual environment used to induce sadness

This VE has already been used in previous studies from our group to show that VEs can be used as an effective mood-induction procedure [9]. Specifically, this VE is able to induce a sad mood in the subjects that navigate through it. The VE is a park in which variations of the following elements traditionally used to induce emotions are included: music [10], Velten self-statements [11] plus pictures (selected from the International Affective Picture System IAPS [12]) and movies [13]. A woman's voice is used to guide the user through the different sections of the park.

This VE will be shown in a retro-projected screen and users will navigate through the environment using a wireless pad (Logitech Rumblepad). EEG will be monitored

by means of an EEG portable device (Emotiv EPOC). The configuration can be observed in Fig. 2.

Figure 2. Subject navigating in the virtual environment while brain activity is monitored with Emotiv EPOC

There will be three experimental groups that will receive different instructions: the cognitive reevaluation group will receive instructions to apply cognitive evaluation strategies during the induction; the expressive suppression group will be told to control the somatic responses to the induced mood; and, finally, the control group will not receive any special instructions to regulate their emotions.

The experimental session will start with participants filling in some questionnaires about their emotional regulation strategies [2-14]. They will also fill in pre-induction visual analogue scales (VAS) and PANAS [15] measures. Following, and with the help of the researcher, participants will practice how to move and interact with virtual objects in a specifically designed training environment. After that, the EEG portable device will be adjusted in the participant's head by the experimenter. Then, the VR session will start, with an approximate duration of 20 minutes. After the session, subjects will fill in again the emotion measurements (VAS and PANAS) and, also, the SUS presence questionnaire [16] to guarantee that they have felt present during the experience. Finally, the participants will be invited to visualize a film to induce them a positive mood before finishing the experiment, which will be checked asking them again to fill in the VAS and PANAS measures.

2. Results

Different spectral parameters of the EEG signals captured during the experience will be calculated and compared between the different experimental groups, to evaluate the influence of the emotional regulation technique on the EEG signal.

The study will focus initially on the analysis of the frontal activity of the EEG (corresponding to these channel names in the International 10-20 locations: AF3, AF4, F3, F4, F7, F8, FC5 and FC6).

3. Discussion

One of the important conclusions that will be extracted from the study will be associated to the role of frontal activity in emotional regulation.

Frontal activity of the EEG seems to reflect not only the degree with which the individual is able to emotionally answer to a specific context (in our study, created with VR technologies), but also his or her capability to inhibit those responses. As long as frontal activity of the EEG should reflect (at least, partially) prefrontal cortex activity, it is probable that the asymmetry of the EEG could be associated with emotional regulation capability [17].

There are several studies that have shown the important role of the prefrontal cortex in emotional regulation [4, 18, 19], although obtaining different lateralization patterns. A recent EEG study which used film clips for emotional induction [5] observed that an effective emotion regulation was associated to a higher bilateral frontal activity in the EEG during the emotional induction of fear or sadness.

Results from the present work will help us to evaluate which of the possible hypotheses of frontal asymmetry of the EEG associated to the suppression or reevaluation of negative emotions is observed during the mood induction with VR. Specifically, it will be analyzed which pattern is observed in the frontal activity of the EEG: left, right or bilateral frontal asymmetry.

Furthermore, the study will allow us to validate the possibilities of portable EEG devices to monitor emotional regulation strategies applied by the participants of VR experiences. The efficacy of the combined used of VR and portable EEG devices for the analysis of emotional regulation strategies will be evaluated. The obtained results will be compared and related with available psychometric instruments for the evaluation of emotional regulation strategies.

Acknowledgments.
This study was funded by Vicerrectorado de Investigación de la Universitat Politècnica de València, Spain, PAID-06-2011, R.N. 1984; by Ministerio de Educación y Ciencia, Spain, Project Game Teen (TIN2010-20187) and partially by projects Consolider-C (SEJ2006-14301/PSIC), "CIBER of Physiopathology of Obesity and Nutrition, an initiative of ISCIII" and Excellence Research Program PROMETEO (Generalitat Valenciana. Consellería de Educación, 2008-157).
The work of A. Rodríguez was supported by the Spanish MEC under an FPI Grant BES-2011-043316.

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