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Validation of a Low-Cost EEG Device for Mood Induction Studies

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Abstract. New electroencephalography (EEG) devices, more portable and cheaper, are appearing on the market. Studying the reliability of these EEG devices for emotional studies would be interesting, as these devices could be more economical and compatible with Virtual Reality (VR) settings. Therefore, the aim in this work was to validate a low-cost EEG device (Emotiv Epoc) to monitor brain activity during a positive emotional induction procedure. Emotional pictures (IAPS) were used to induce a positive mood in sixteen participants. Changes in the brain activity of subjects were compared between positive induction and neutral conditions. Obtained results were in accordance with previous scientific literature regarding frontal EEG asymmetry, which supports the possibility of using this low-cost EEG device in future mood induction studies combined with VR.

Keywords. EEG, Emotiv Epoc, Mood Induction, EEGLAB, IAPS

Introduction

In emotional studies, the frontal electroencephalographic (EEG) asymmetry model states that each hemisphere is specialized in processing different emotions [1]. This model declares that there exists an asymmetry in the activity of the frontal lobe of the brain, and by means of this asymmetric activity it is possible to moderate and process different emotional responses. Consequently, frontal EEG asymmetry can be evaluated and applied to distinguish the affective valence of an emotion felt.

Findings from numerous studies show an evident consensus that an increase of left frontal activity and a decrease of right frontal activity are associated with positive emotions, and that an increase of right frontal activity and a decrease of left frontal activity are associated with negative emotions. This has originated the approach/withdrawal model of Davidson [2-3] and is consistent with brain injury studies.

The results of previous studies were obtained through EEG signal measurements, where the participants were in a rest moment. Others studies have complemented this interpretation about frontal EEG asymmetry during a mood induction procedure. They have considered interesting to measure the frontal EEG signal in specific emotional

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contexts with the aim of analyzing the ability of each individual to respond emotionally [2-3]. It was observed that frontal EEG asymmetry, during a fear induction, was a better negative affect predictor than an analysis of EEG in a rest condition. However, the positive affect could be predicted by EEG analysis both during a rest condition and a positive induction moment.

Clinical EEG devices have been used in most of these studies. The majority of these systems are very precise but they have as disadvantages that they are expensive, intrusive and difficult to use by the therapist.

Recently, the new low-cost EEG devices, which are appearing on the market, provide great portability and a good quality brain signal. Moreover, these EEG devices have a great compatibility with other technologies, such as Virtual Reality. Low-cost EEG devices could be used in a Virtual Reality study without influencing the progress of this study.

In the present work, the possibilities of EEG monitoring through a portable device to evaluate mood induction of participants were analyzed. Therefore, the goal of this study was to analyze if a low-cost EEG device (specifically, the Emotiv EPOC) was able to measure changes in brain activation in the frontal EEG while a positive mood was inducted to the subjects.

1. Materials and Methods

Sixteen healthy participants, 8 men and 8 women, were evaluated in this study, all of them right-handed and with ages between 23-30 years old with normal o corrected-to-normal vision. The subjects were university students without any psychological disorder and none of them was an expert in the use of the technologies applied in this study. They signed an informed consent for allowing their data to be used in this study. It was not necessary to exclude any participant due to wrong registration of the EEG signal.

The EEG signal was monitored by means of an EEG portable device, Emotiv EPOC [4] which had 14 EEG channels using the standard 10/20 layout and 2 reference channels (CMS/DRL), Fig 1.

Figure 1. Emotiv EPOC device and Emotiv EPOC electrodes positioning on standard 10/20 layout.

EEG recordings were analyzed off-line using custom software written in MATLAB. This custom software was based on EEGLAB [5] tools. Many EEG functions were used to clean the EEG-data and analyze changes in alpha-spectral power.

In the study, the participants had to watch positive and neutral pictures of IAPS [6], which were used as mood induction stimulus, in a desktop screen.

The experimental session was divided into four steps of two minutes each. In the first step, the participants had to watch a black screen (rest stage). In the second step, the emotional pictures were presented (15 neutral pictures). In the third step, another rest stage was presented. And in the last step, the other emotional pictures were presented (15 positive pictures). Steps number two and four were counterbalanced.

A two way repeated measured ANOVA was applied, being the independent factors the experimental moment, Neutral Condition versus Positive Induction, and brain hemisphere (right/left). Alpha-ERD (1) values, calculated for F3 (left hemisphere) and F4 (right hemisphere) [2, 7, 8] sensors, were used as dependent variables. F3 and F4 were used because they are the sensors more used in the scientific literature to analyze the valence of the participants as they are located above the dorsolateral prefrontal cortex [9].

$$AlphaERD = \frac{Alpha\ Power\ Rest - Alpha\ Power\ Induction}{Alpha\ Power\ Rest} \quad (1)$$

2. Results

Results showed significant differences between neutral and positive moments ($F(1,15)=5.859$; $p=0.029$) and a significant influence of the intersection factor between hemisphere and moment ($F(1,15)=9.594$; $p=0.007$).

Pair-wise comparisons only showed significant differences between hemispheres during the positive induction ($p=0.010$).

Table 1. Mean and standard deviation Alpha-ERD values of the F3 and F4 sensors.

Sensor	Neutral Condition		Positive Induction	
	Mean	*Std.*	*Mean*	*Std.*
F3	1.094	5.074	1.600	5.803
F4	0.386	4.545	-3.649	1.026

A decrease was observed in the Alpha-ERD in the right hemisphere and an increase in the left hemisphere when the positive emotion was inducted. Mean values and standard deviation values of each sensor can be seen in the Table 1.

Figure 2 shows three topographic scalp maps, which give a visual representation about the distribution of average alpha ERD values around scalp in the positive moment, the neutral moment and the difference between positive and neutral moments, respectively.

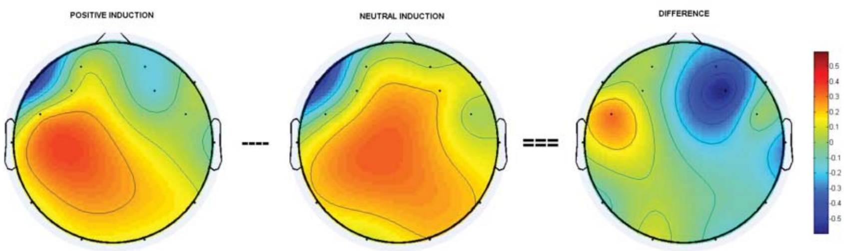

Figure 2. Topographic scalp map of average alpha ERD values.

3. Discussion

The goal of this study was to analyze if a low-cost EEG device would be able to measure changes in brain activation in the frontal EEG while a positive mood was inducted to the subjects through emotional pictures.

Statistical results show activation in the left hemisphere significantly greater than in the right hemisphere during the positive images visualization. This activation was greater during positive induction than during neutral induction.

In the figure 2, the difference between alpha ERD values for each moment can be seen. It shows that there is a right hemisphere deactivation and an increase in the left hemisphere during the positive induction, in comparison with the neutral induction moment.

These results show evidence of a frontal asymmetry in the EEG of the participants during a positive induction, which is in accordance with science literature [1, 2, 8], that affirms that activation of left hemisphere is linked with positive emotion induction [1, 2, 7, 8, 9].

This results support the possibility of using the low-cost EEG devices, in particular Emotiv Epoc, as an emotional measuring tool in future studies.

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