 DOI: 10.3217/978-3-85125-467-9-130

My Virtual Dream: Brain Computer Interface in an Immersive Art Environment

Amna Ghani[1,2*], Omar Mendoza-Montoyo[3], Anthony Randal McIntosh[4], Petra Ritter[1,2,5]
[1]Department of Neurology, Charite´—University Medicine, Berlin, Germany; [2]Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Germany; [3]Freie Universität, Berlin, Germany; [4]Rotman Research Institute of Baycrest Centre, University of Toronto, Toronto, Canada; [5]Minerva Research Group Brain Modes, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

E-mail: amna.ghani@charite.de

Introduction: Most of the Brain Computer Interface (BCI) experiments are performed in the controlled laboratory environment with the high number of repetitions, known as training. However, living in the world full of chaos will never allow us to achieve same classification accuracy when performed outside the lab environment with no to minimal amount of training. This motivates a question '**How to implement BCI technologies in open-environment but at the same time retaining the similar amount of accuracy as in controlled environment?'**. My Virtual Dream (MVD) [1], a step to answer this question and making BCIs publicly available. Powered by The Virtual Brain [2], MVD is science and art installation that allows general public to learn about their brains by providing them audio-visual neurofeedback.

Materials, Methods and Results: Total 64 subjects participated in a public event that took place in the Irvine University in October 2015. The complete experiment consisted of 16 sessions. In each session, 4 volunteers interacted simultaneously with a passive-BCI that measures two cognitive states: relaxation and focus. The electrophysiological activity was recorded by placing an Emotiv EEG headset (14 sensors, 128 Hz of sampling rate) on each participant. Only 5 channels were used in this experiment: AF3, P7, P8, O1 and O2.

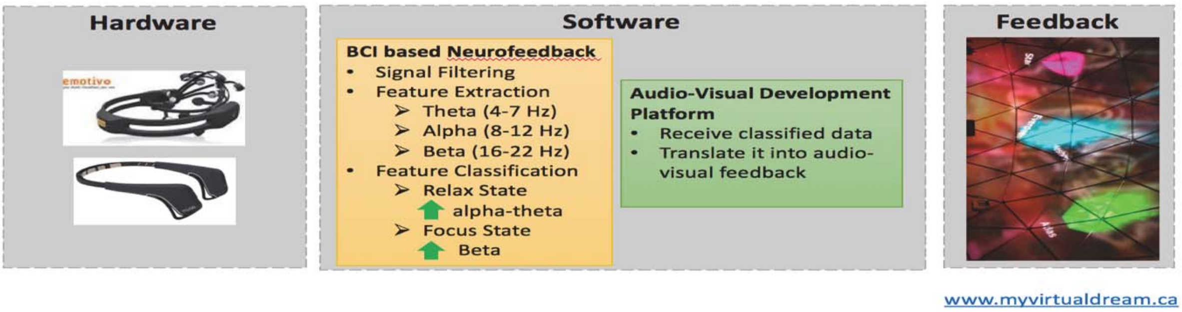

Figure 1 *Flow of data in MVD: EEG signals acquired from headsets (hardware) are further pre-processed to extract important features (software) and changes in these features are represented as a audio-visual symbols (feedback)*

The cognitive features were calculated according to the relative increments in power in three bands: theta (4-7Hz), alpha (8-12 Hz) and beta (16-22 Hz). Channels with ocular or motion artifacts were detected and excluded from the analysis. The audio-visual feedback consisted of a projected scene with four avatars, each one controlled by one participant. The size, glow, colors and positions of these avatars represent the states that the BCI calculates for each subject. At the same time, the users' scores control the music layers and several visual elements projected into the scene, creating in this way a unique artistic representation with several auditory and visual stimuli.

Discussion: Our survey results show that majority of our participants (73%) reported good control over their avatar. This, as a first step, suggests that BCI technologies can be implemented and tested in the real world environment with minimal amount of training. Further analysis will be performed on the participants' EEG data and neurofeedback scores to reveal other interesting effects.

Significance: MVD is a step towards encouraging BCI researchers to implement and test BCI paradigms in real world scenarios. Thus, allowing us to conclude the performance of core BCI components, such as artefact rejection, signal processing and classification algorithms that might have high accuracies even under the effects of surrounding stimuli. At the same time, providing neurofeedback with artistic visuals and musical tones makes MVD a perfect platform to study the effects of artistic beauty on the human brain [3]. Thus, we expect that MVD will not only be able to increase the performance of real time BCI but also enhance our knowledge about the field of neuroaesthetics.

References:

[1] Kovacevic N, Ritter P, Tays W, Moreno S, McIntosh AR (2015) 'My Virtual Dream': Collective Neurofeedback in an Immersive Art Environment. PLoS ONE 10(7): e0130129.
[2] Ritter, P., M. Schirner, A.R. McIntosh, V. Jirsa (2013). "The virtual brain integrates computational modeling and multimodal neuroimaging." Brain Connect 3(2):121-145.
[3] Cupchik, G. C., Vartanian, O., Crawley, A., & Mikulis, D. J. (2009). Viewing artworks: contributions of cognitive control and perceptual facilitation to aesthetic experience. *Brain and cognition*, *70*(1), 84-91.