

Development of a software prototype for neurofeedback training using electroencephalography

Lucas T. Menezes*, João O. F. Pigatto, Thiago B. S. Costa, Mariana S. Pavan, Mônica A. Cotta, Gabriela Castellano

Abstract

Neurofeedback (NFB) training is a technique that claims that an individual can modulate their own brain signals - and consequently brain states - via self-regulation during a brain signal acquisition procedure. The most used brain signal acquisition technique for NFB has been electroencephalography (EEG). Thus, the goal of this work was to develop a software prototype for NFB training using EEG that extracts a given feature from the EEG signal and returns it to the user and the experimenter - through a simple bar graph, for example.

Key words:

Neurofeedback, EEG, software prototype

Introduction

Since its first appearance in the 1960s, the so-called electroencephalography (EEG)-biofeedback has been object of speculation and, mainly over the 1980s, it was sidelined by scientists around the world because of the lack of scientific approval. Over the past decade, though, the technique has been broadly studied and named as neurofeedback (NFB) [1]. The most used technique for NFB has been EEG, due to the nature of the signal it measures: electrical potentials generated by neuron populations. It also has the advantages of relatively low cost, portability and high temporal resolution. Briefly, an EEG-NFB training procedure consists of capturing the electrical potentials generated in some region of interest (ROI) of a subject's brain, measured from the scalp; the signal is then processed in real-time by a software, and some signal feature – e.g., the theta band (4-7 Hz) power – is extracted. This feature is presented to the subject through a simple interface – e.g., a bar graph – and the subject is requested to excite or inhibit brain activity of this ROI by simply increasing or decreasing the size of the bar graph. The goal of the present work was to develop a prototype software for EEG-NFB, to be later used to assess the efficiency of NFB training. This prototype is the initial part of a larger study that aims to evaluate the efficacy of NFB training.

Results and Discussion

EEG signal acquisition was performed with the g.USBamp amplifier, a pre-amplifier g.SAHARAbox and 16 g.SAHARA 7 mm dry electrodes (g.tec, Austria, www.gtec.at). The electrodes were set on a cap using the extended 10/20 system, with the reference electrodes placed above the mastoids. The NFB prototype was developed in Matlab using as a starting point a Matlab API for g.USBamp provided by g.tec. The EEG signal is acquired and processed in real-time. Processing consisted of performing a Fast Fourier Transform, applying a notch filter at 60 Hz, and bandpass filtering the signal from the specified ROI (electrode) at the specified frequency band. Bands commonly used for NFB are theta (4-7 Hz), alpha (8-12 Hz), low beta (12-20 Hz), high beta (20-30 Hz) and SMR (sensorimotor rhythm, 12-15 Hz), in addition to several ratios, such as theta/beta [2]. The amplitude of the selected band or feature (such as the

theta/beta ratio) is then presented to the subject in the form of a bar graph (Figure 1).

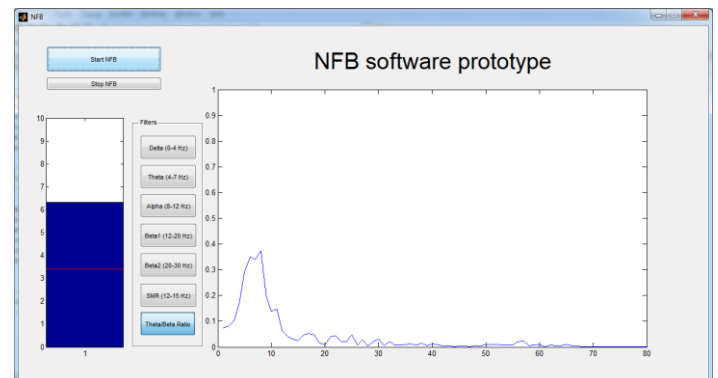


Figure 1. Interface presented to the user and the experimenter. The latter can determine the frequency ranges for NFB and analyze in real-time the subject's brain activity.

Conclusions

A software prototype for NFB training has been developed. The software is already operating. The next step will be to define the best way to present a threshold (goal) for the subject to surpass (reach) with his/her training. For this, trials with healthy subjects will be conducted. Furthermore, the NFB training per se will be evaluated.

Acknowledgement

We thank FAPESP, FINEP and SAE-UNICAMP for financial support.

¹ Gruzelier, J. H. *Neurosci. Biobehav. Rev.* **2014**, *44*, 124.

² Leins, U., Goth, G., Hinterberger, T., Klinger, C., Rumpf N. and Strehl, U. *Appl. Psychophys. Biof.* **2007**, *32*, 73-88.