Editorial

BCIs and physical medicine and rehabilitation: The future is now

**ARTICLE INFO**

**Keywords:**
Brain Computer Interface  
BCI  
Rehabilitation

The (critical) development of Brain Computer Interfaces (BCIs) in the last two decades raised new hopes for disabled patients. In healthy persons, BCIs offer promising scopes for application in the field of entertainment or video gaming. Those commercial potential perspectives for applications in the digital industry explain a renewed interest in a subject until now highly confidential.

Generally speaking, in medical applications, BCI involves:

- the recording of brain signals generated by the patient, as he/she performs a particular mental or “real” task;
- the decoding and transformation of this signal into a specific action;
- and a feedback given to the patient.

This technology relies either on implanted electrodes – so-called “invasive BCI” – or on external devices recording brain signal – so-called “non-invasive BCI”. Most studies on patients have been conducted with non-invasive BCI but rapid progresses in the implanted materials and enlargements in Deep Brain Stimulation indications may change the future and the way we consider those technologies.

This special issue of the *Annals of PRM* is dedicated to the applications of BCI technologies in neuro-rehabilitation. Although in its infancy, several recent experiments showed the potential usefulness of BCI to compensate or restore motor and cognitive impairment (for a review see: [1]).

One of the most obvious applications is the use of BCI to control a robotic orthesis or another device (like a wheelchair for example) as a substitute for motor loss. Following animal studies showing that a monkey was able to modulate his cortical activity to control a prosthetic device [2,3], the same approach has been applied to patients with tetraplegia (see: [4,5]). After a stroke, BCI could also favor motor recovery through the enhancement of brain plasticity or the re-equilibration of inter-hemispheric imbalance (for a review in this special issue see Van Dokkum et al. [6]). In another article of this issue, Chaudhary et al. [7] report their contribution to this field showing how BCI can improve recovery of hand function after stroke using the brain signal to activate a functional electrical stimulation (FES) delivered to the paretic muscles.

BCI may also be advantageously utilized in order to restore or enhance communication in patients with severe neurological impairments. In this special issue, Chaudhary et al. [7] reviewed the current literature using non-invasive BCI tools – electroencephalography (EEG) and near-infrared spectroscopy (NIRS) – to restore a functional communication in patients suffering from amyotrophic lateral sclerosis (ALS) with complete paralysis. In another study published in this issue, Mattout et al. [8] described the “P300 speller”, one of the most advanced BCI communicative tool based on the detection of a P300 wave when the attended letter appears on a computer screen. In this latter article, the authors screened the challenges and technical gaps to apply efficiently this assistance to paralyzed patients. The same P300 signal has been incorporated in a BCI row-column scanning board with verbal and non-verbal instructions adapted to individuals with cerebral palsy (see Scherer et al. [9] in this issue). The establishment of a reliable communication is also one of the main goals for patients with disorders of consciousness (DOC). The willful modulation of brain activity recorded in patients considered in a vegetative state [10] led some authors to develop BCI applications for communication purposes using either the electroencephalography (EEG) signal (e.g. [11]) or fMRI paradigms (e.g. [12]). These articles are critically
analyzed with regard to the potential applications at the patient’s bedside (see Luauté et al. [13] in this issue).

Altogether, there are now some evidences that BCI technology can improve the independence of patients with devastating neurological disorders. However, most of the current literature is based on proof of principle studies. More research is still needed to find the best candidates and the optimal delay since insult, to improve the efficiency of signal detection and decoding, to facilitate the portability of the devices and the cost of these techniques. Moreover, as pointed out by Nijboer [14] in this issue, BCIs should be developed to be usable rather than only reliable, and BCIs will also need to be competitive with existing alternatives in terms of efficiency and user experience and satisfaction.

In this perspective, it appears crucial that the development of BCIs and transfer of this technology to patients involves rehabilitation of professionals at the early stage of design processes. This technology is an excellent example of the urgent need of translational studies involving neuroscientists, engineers and clinicians. PRM doctors should not miss the train.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References