L'HOMME CONNECTÉ

Se connecter au cerveau en temps-réel pour des applications en recherche clinique et fondamentale

Connecting to the brain in real-time for applications in clinical and basic research

Jérémie Mattout*, **, Gaëtan Sanchez*, **, Olivier Bertrand*, **, Margaux Perrin*, ** and Emmanuel Maby*, **

**INSERM, U1028; CNRS, UMR5292; Lyon Neuroscience Research Center, Brain Dynamics and Cognition Team, Lyon, F-69000, France*

***University Lyon 1, Lyon, F-69000, France*

jeremie.mattout@inserm.fr, gaetan.sanchez@inserm.fr, olivier.bertrand@inserm.fr, margaux.perrin@yahoo.fr, emmanuel.maby@inserm.fr

Mots clés : Interfaces cerveau-machine (ICM), Electrophysiologie temps-réel, Neurosciences cognitives, Applications cliniques

Keywords: Brain Computer-Interfaces (BCI), Real-time electrophysiology, Cognitive Neuroscience, Clinical Applications

Brain-computer interfaces (BCI) aim at bypassing the usual nerve and muscle pathways to connect the brain with the outside world directly. This scientific and technical challenge holds great promises, especially in the health domain, to restore communication in locked-in patients [1], to enable the control of neuroprosthetics [2,3], but also to possibly complement pharmacological therapies in some neurological and psychiatric disorders, via brain training or neurofeedback. At the heart of most BCI research lies the issue of processing brain signals in real-time. Hence BCI builds on several key disciplines, including basic neuroscience, human electrophysiology as well as neuroimaging, advanced signal processing and machine learning.

In this brief communication, we will give a general introduction to BCI and then illustrate current applications and perspectives with examples of our own current research, spanning a large spectrum of potentialities. Namely, we will highlight the different invasive and non-invasive techniques that are used to measure brain activity and the context in which they are exploited.

The first example we will focus on is the so-called "P300-speller", an electroencephalography (EEG) based BCI and probably the most well-known application today. It aims at enabling disabled patients to communicate thanks to the distinction between brain responses to attended and non-attended stimuli. This typical example illustrates how improvements in information transfer can be obtained with adaptive machines which in turn trigger up human motivation [4].

The second example describes a very recent and original approach which illustrates how real-time electrophysiology could be used in cognitive neuroscience to improve hypothesis testing [5] and hence help refining our understanding of the neural correlates of mental states. A fundamental question that is crucial to BCI itself.

Altogether, those examples emphasize the important features of this new interaction paradigm for the brain [6].

Références bibliographiques

1- Birbaumer N, Ghanayim N, Hinterberger T, Iversen I, Kotchoubey B, Kübler A, Perelmouter J, Taub E, Flor H. (1999) A spelling device for the paralysed. Nature 398, 297-298.

2- Hochberg LR, Serruya MD, Friehs GM, Mukand JA, Saleh M, Caplan AH, Branner A, Chen D, Penn RD, Donoghue JP. (2006) Neuronal ensemble control of prosthetic devices by a human with tetraplegia. Nature, 442, 164-171.

3- Jerbi, K.; Vidal, J. R.; Mattout, J.; et al. (2011) Inferring hand movement kinematics from MEG, EEG and intracranial EEG: From brain-machine interfaces to motor rehabilitation IRBM, 32: 8-18.

4- Coadaptation cerveau machine pour une interaction optimale : application au P300-Speller. Thèse de Margaux Perrin, 2012.

5- Sanchez G., Daunizeau J., Maby E., Bertrand O., Bompas A. and Mattout J. (2014). Toward a new application of real-time electrophysiology: online optimization of cognitive neurosciences hypothesis testing. Brain Sci.4, 49-72.

6- Mattout J. (2012) Brain-computer interfaces: a neuroscience paradigm of social interaction? A matter of perspective. Front Hum Neurosci. 6:114. doi: 10.3389/fnhum.2012.00114.