



HAL
open science

Hybrid Brain-Machine Interface to palliate the motor handicap caused by Duchenne muscular dystrophy: a case report

Alban Duprès, François Cabestaing, José Rouillard, Vincent Tiffreau, Charles Pradeau

► To cite this version:

Alban Duprès, François Cabestaing, José Rouillard, Vincent Tiffreau, Charles Pradeau. Hybrid Brain-Machine Interface to palliate the motor handicap caused by Duchenne muscular dystrophy: a case report. 12th World Congress of the International Society of Physical and Rehabilitation Medicine, Jul 2018, Paris, France. Elsevier, 61, Supplement, pp.e494, 2018, Annals of Physical and Rehabilitation Medicine. 10.1016/j.rehab.2018.05.1150 . hal-01915095

HAL Id: hal-01915095

<https://hal.science/hal-01915095>

Submitted on 7 Nov 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Hybrid Brain-Machine Interface to palliate the motor handicap caused by Duchenne muscular dystrophy: a case report

Alban Duprès¹, François Cabestaing², José Rouillard², Vincent Tiffreau³, and Charles Pradeau³

¹Institut Supérieur de l'Aéronautique et de l'Espace (ISAE-SUPAERO), 31400 Toulouse, France

²Univ. Lille, CNRS, Centrale Lille, UMR 9189 - CRISTAL, 59655 Villeneuve d'Ascq Cedex, France

³Physical Medicine and Rehabilitation Unit, University Hospital of Lille, University of Lille, URePSSS, EA 7369

Abstract Topic: Robots, Aids and Devices.

I. BACKGROUNDS AND AIMS

We describe a hybrid Brain-Machine Interface (hBMI), designed for improving DMD (Duchenne Muscular Dystrophy) patients' autonomy. We assess relevance of our hBMI with 2 DMD patients performing the virtual driving task shown in figure 1. To adapt our hBMI to patients motricity, it allows hand movement (real or intentional) detection by processing signals from electroencephalography (EEG), electromyography (EMG), and joysticks.

It allows using different applications, by controlling an object (real or virtual) trajectory through movements of right hand, left hand, or both hands simultaneously. Right and left hand movements result in respectively a left and right rotation, whereas both hands movements move the object forward [1], [2].



Figure 1: Karting driving task

II. METHOD

Patients (men, 20/28 years) realized home-based experiments, using a portable equipment, thanks to a collaboration with Lille University Hospital and *Centre Hélène Borel* (Lille, France).

As shown in figure 2 (Left) patient is seating in front of a computer displaying the task and recording 12 EEG signals

from the primary motor cortex. Figure 2 (Right) shows EMG electrodes location over each hand.

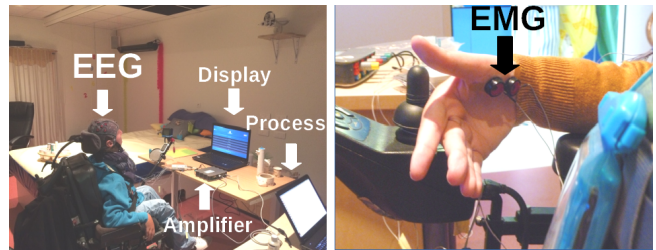


Figure 2: (Left): Hybrid BMI experiment overview. (Right): EMG location

Patients instruction was to make 2 laps, by making hands movements detected in real time by processing EMG signals in OpenVIBE software [3].

III. RESULTS

Figure 3 compares patients performing times (in seconds) to those of 10 healthy subjects performing the same task. Patients performances look quite similar to those of healthy subjects, suggesting that our hBMI is relevant for DMD patients. Moreover, we observe a learning effect between the two laps, expecting improvement with training.

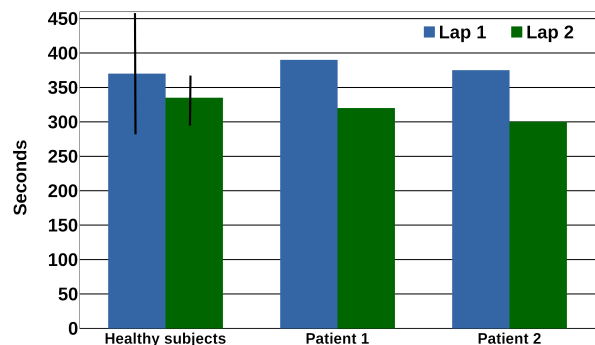


Figure 3: Lap times (seconds) for healthy subjects and DMD patients

IV. CONCLUSIONS

After this conclusive preliminary study, we plan further experiments including more DMD patients. Offline EEG processing enables to identify motor-related patterns [4], necessary to detect movements at the cerebral level, and to propose an interface adapting to patient motricity.

REFERENCES

- [1] A. Duprès, J. Rouillard, and F. Cabestaing, "Hybrid BCI for palliation of severe motor disability," in *Proceedings of the 26th Conference on L'Interaction Homme-Machine*, ser. IHM '14. ACM, 2014, pp. 171–176, DOI: 10.1145/2670444.2670466.
- [2] G. Dudek and M. Jenkin, *Computational principles of mobile robotics*. Cambridge university press, 2010.
- [3] Y. Renard, F. Lotte, G. Gibert, M. Congedo, E. Maby, V. Delannoy, O. Bertrand, and A. Lécuyer, "OpenViBE: An Open-Source Software Platform to Design, Test, and Use Brain-Computer Interfaces in Real and Virtual Environments," *Presence: Teleoperators and Virtual Environments*, vol. 19, no. 1, pp. 35–53, 2010. [Online]. Available: <https://doi.org/10.1162/pres.19.1.35>
- [4] G. Pfurtscheller and F. L. da Silva, "Event-related EEG/MEG synchronization and desynchronization: basic principles," *Clinical Neurophysiology*, vol. 110, no. 11, pp. 1842 – 1857, 1999. [Online]. Available: <http://www.sciencedirect.com/science/article/pii/S1388245799001418>