

A vibrotactile-based brain-computer interface for assessment and communication in patients with disorders of consciousness

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PATIENTS with disorders of consciousness (DOC) usually stay in a rehabilitation institution for several months before they are released to professional home-care or to a private home - often without professional or technical support. In these institutions, it is advantageous to have a system that can assess the cognitive functions by using (i) auditory evoked potentials, (ii) vibrotactile evoked potentials and (iii) motor imagery experimental protocols. Cruse et al. already demonstrated that one can use this way of stimulation for communication and also for assessment of the level of consciousness in patients classified as non-responsive [1]. Both the auditory and vibrotactile experiments are designed to elicit a P300. The motor imagery based system allows measuring and analyzing event-related desynchronization/synchronization driven by motor imaginations of the subject. The aim of the current study was to test if patients suffering locked-in syndrome (LIS) and healthy control subjects can use a vibrotactile BCI system to establish communication. Six LIS patients and 10 control subjects performed an mental counting task embedded in an oddball paradigm to elicit a P300 response. Then the participants had to answers five questions counting the vibration on either the right wrist for ‘yes or the left wrist for ‘no’. An accuracy level was calculated by counting the number of correct classified deviant stimuli. All control subjects and patients were able to elicit a P300 wave using the vibrotactile paradigm. In all performed experiments five out of six patients and all control subjects reached a classification accuracy above chance level (50% in the counting task, 33.3% in the communication task). Details can be seen in Table 1. The study showed the feasibility of using a vibrotactile based BCI system for communication in control subjects and LIS patients. In combination with auditory and motor imagery based paradigms a testing battery exists that can be used for the detection of consciousness in non-communicating patients due to severe brain injuries.

Table 1: Accuracy levels of healthy control subjects users and patients suffering LIS during the two tasks

controls subjects	Counting task	Communication task	LIS patients	Counting task	Communication task
1	100%	100%	1	100%	60%
2	100%	100%	2	20%	20%
3	100%	100%	3	100%	40%
4	100%	60%	4	100%	60%
5	100%	40%	5	60%	40%
6	100%	60%	6	100%	100%
7	100%	100%	Average	80%	53.30%
8	100%	60%			
9	100%	80%			
10	100%	100%			
Average	100%	80%			

REFERENCES

- [1] [1] Cruse, D., Chennu, S., Chatelle C., Bekinschtein, T. A., Fernández-Espejo, D., Pickard, J. D., Laureys, S. & Owen, P. A. M.. (2011), Bedside detection of awareness in the vegetative state: a cohort The Lancet, vol. 378, pp. 2088-2094.

This work was supported in Research supported by the European Union FP7 Integrated Projects DECODER and BackHome. Christoph Kapeller and Christoph Guger are with Guger Technologies OG, Schiedlberg, Austria, Schiedlberg, 4521 Austria (corresponding author to provide phone: +43-07251-22240; e-mail: kapeller@gtec.at, guger@gtec.at).