EEG-based brain-computer interface in chronic tetraplegics to actuate a robotic arm device as assistive technology – clinical survey and long term post trial follow-up

Running Title: Brain-computer interface in chronic tetraplegics

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Abstract
Study Design: Clinical survey and interviews/ correspondence within long term post-trial follow-up, on 9 chronic, post spinal cord injury tetraplegics.
Objective: To assess efficiency of the use of an Electroencephalography-based Brain Computer Interface (EEG-BCI) for reaching/ grasping assistance in tetraplegics, through a robotic arm.
Settings: Physical and (neuromuscular) Rehabilitation Medicine, Cardiology, Neurosurgery Clinic Divisions of TEHBA and UMPCD, in collaboration with “Brain2Robot” (composed of the European Commission-funded Marie Curie Excellence Team by the same name, hosted by Fraunhofer Institute-FIRST), in the second part of 2008.
Methods: The enrolled patients underwent EEG-BCI training sessions.
Statistics entailed multiple linear regressions and cluster analysis.
Follow-up - including questionnaire on patients’ perception upon their EEG-BCI control capacity - continued up to 14 months after the experiments.
Results: EEG-BCI performance/ calibration-phase classification accuracy averaged 80.99 %; feedback training sessions averaged 70.51% accuracy, for 8 subjects who completed at least one feedback training session; 7 (77.7%) of the 9 subjects reported having had the feeling to control the cursor; 3 (33.3%) subjects felt they were also controlling the robot through their movement imagination.
BCI performance was positively correlated with beta (13-30 Hz) spectral power density (coefficient 0.432, standardized coefficient 0.745, p-value=0.025); with possible influence was also the sensory AIS score (range: 0 min to 224 max, coefficient -0.177, std. coefficient -0.512, p=0.089).

Conclusion: Potential self-assistance for chronic tetraplegics by EEG-BCI actuated mechatronic devices we herein observed, was mainly related to density of EEG in the beta range, positively (increasing therewith) and to AIS sensory score (negatively).

Keywords: spinal cord injury, brain computer/machine interface, electroencephalogram, mechatronic/robotic arm device, quality of life.