Brain-computer interface (BCI) is a system which provides communication based solely on the measured brain activity. BCIs were initially constructed in order to establish contact with patients with the locked-in syndrome. More recently they gained much popularity in multimedia applications which in turn contributed to their advancement.

Coma is a state of deep disorder of consciousness (DOC), appearing similar to the brain death. Patients in coma do not respond to any stimuli, regardless of their intensity. It is usually caused by brain traumas as well as diseases and intoxications which cause brain injury. Owing to the advances in medicine, intensive care and neurology more and more patients are able to survive the first critical days after a trauma or intoxication. It is estimated that even 5,000 children fall into the coma every year in Poland alone. Most often coma lasts no longer than a fortnight after which most patients wake up completely. However statistically a few hundred children do not wake up from coma, instead staying in the vegetative state (VS) or the minimally conscious state (MCS) for many years. With such patients in mind, the “Budzik” clinic (http://www.klinikabudzik.pl) was established, where the children undergo an intensive process of rehabilitation.

The mechanisms of consciousness generation are among the greatest unsolved mysteries of the neuroscience. Neurological diagnosis suggests that the consciousness levels strongly vary among different patients with DOC. Some of them make involuntary movements, most of them open their eyes and appear to respond to the guardian’s voice. Main questions asked by the physicians and patients’ families are: Does the child hear and understand? Why do only certain children improve through rehabilitation? What is the main factor? What are the chances of waking up from coma? The modern medicine cannot provide clear answers to any of those questions.

In June 2008, PI of this project conducted the first public demonstration of brain-computer interface in Poland. For many years, he has been leading one of the strongest research groups dedicated to this field. Beside many international publications and the participation in the EC 7FP "BRAIN" project, the group presented innovatory BCI Appliance system, which turned out to be the fastest BCI presented on CeBIT 2012 international fair. In 2010, within the European campaign COST BM0605 “Consciousness: A Transdisciplinary, Integrated Approach”, the group teamed with the strongest research group in Europe dedicated to the disorders of consciousness — the Coma Science Group, led by prof. Steven Laureys.

The above-mentioned circumstances give this project a real chance of success by adopting methodology, algorithms and software developed for brain-computer interfaces. Evaluation of the state of consciousness of patients with different consciousness disorders will be performed in a way that will maximise the chance of establishing communication with patients in hopeful conditions.

Attempts undertaken within the Project will provide an opportunity for the enormous accomplishment — demonstration of the possibility of establishing communication (in a stable and reproducible manner) with children in locked-in syndrome by using brain-computer interfaces. In order to develop a stable consciousness assessment methods, based on reproducible electrophysiological indicators and procedures of qualification and proceeding with patients, one must solve a number of problems from different areas including neuroinformatics, biomedical engineering and signal analysis. The final success would be a breakthrough in the treatment of patients suffering from disorders of consciousness.