Abstract for the general public

Quantitative disorders of consciousness, commonly referred to as "comatose states" in everyday language, encompass a spectrum of neurological disorders that occur following severe brain injuries, such as prolonged brain hypoxia or head trauma resulting from traffic accidents. Within these conditions, we distinguish states such as coma, unresponsive wakefulness syndrome (also known as vegetative state), and minimally conscious state. One of the main challenges associated with these disorders, alongside issues like prognosis, rehabilitation, or long-term patient care, is diagnosis—specifically, accurately distinguishing between states accompanied by consciousness, such as the minimally conscious state, and those devoid of it, such as coma or unresponsive wakefulness syndrome. Proper diagnosis is crucial as it significantly impacts the subsequent course of treatment.

There are external signs of consciousness, such as the ability to communicate with or follow commands. Unfortunately, patients in comatose states often suffer from motor or verbal limitations that prevent them from demonstrating their retained mental capacities, including the fact that they are aware of themselves and their surroundings. Therefore, examining the brain activity of patients is crucial—as it allows for detecting specific patterns of response and activity indicative of consciousness which are independent of motor responses. This is one of the primary goals of this research proposal. We are particularly interested in spontaneous brain activity and responses to auditory stimuli. In previous studies, we have recognized promising indicators that can aid in differentiating between states like unresponsive wakefulness syndrome and the minimally conscious state. In our planned research, we aim to explore this intriguing topic further to better understand the role of auditory activity in the brain mechanisms associated with consciousness. We are especially interested in the role of mechanisms related to the brain's creation of predictions about patterns of sensory stimulation. Our research will attempt to identify brain responses observed during auditory stimulation related to detecting irregularities in these patterns. We aim to verify the hypothesis that brain mechanisms related to prediction are specific to the conscious brain and break down in states of impaired consciousness.

Standardized clinical scales, based on systematic observation of patient behavior, are a significant aid in the proper diagnosis of comatose states. Unfortunately, Polish researchers and clinicians currently have relatively few such tools. As part of our project, we aim to adapt scales used abroad that measure the preserved linguistic abilities of patients and allow for the involvement of caregivers—particularly the family—and medical staff in the diagnostic process. Undoubtedly, their good, long-term familiarity with the patients can contribute to better diagnosis.

Finally, the project will attempt to integrate measures based on diagnostic scales and identified EEG markers to create a multimodal approach to diagnostic assessment in disorders of consciousness. This approach is intended to increase the accuracy of assessing the state of patients, including those with significant motor and verbal limitations. From a theoretical perspective, the results obtained will allow for a better understanding of the specific neuronal dysfunctions leading to disorders of consciousness. The project's goals and implementation are linked to the EC-funded Marie Skłodowska-Curie Action "DOC-BOX" project, in which the project leader is a participant. Within this project, through a consortium involving key research and clinical centers focused on studying disorders of consciousness, visits of scientists to participating centers are funded. This will enable members of the research team of this project to extend their competencies in the latest scientific advancements regarding the nature of quantitative disorders of consciousness following severe brain injuries.