The spinal cord contains specialized motor neurons (motoneurons), whose axons reach the muscles through the nerves and transmit impulses (electrical potentials) from the nervous system to the muscle fibers, resulting in contraction. Determination of parameters motoneuron excitability and characteristics of their electrical activity are crucial for understanding the mechanisms of force development and motor control, and are also important in pathology, e.g. with respect to muscle spasticity.

The project concerns changes in the level of activity of neuronal networks of the spinal cord under influence of electrical fields (polarization induced by external, trans-spinal or trans-cutaneous direct current stimulation), which directly and indirectly affects the activity of motoneurons. The effects of polarization of the spinal cord are now the subject of extensive research of clinicians and neurophysiologists in many research centers around the world. Polarization of neurons is a new neuromodulation method that has recently been used more and more frequently (despite many unknowns in terms of mechanisms and neuronal interactions in the spinal cord) in rehabilitation of patients after neurological injuries or as a supplement to physical training.

There is no data in literature on the direct effects of trans-spinal polarization on motoneuron properties. The results of the planned study will be innovative: (1) for the first time they will answer the question of how changes in electrical fields induced by trans-spinal direct current stimulation (positive or negative) modulate the electrophysiological properties of the spinal motoneurons; (2) for the first time the long-term effects of polarization of the spinal cord will be investigated.

The research will be carried out on an animal model - adult male rats, under the same experimental conditions, in homogeneous age groups, from the same breeding and of the same level of daily physical activity. Experiments on 130 animals are planned.

Research hypotheses based on the pilot study, assume that (1) externally applied electrical fields immediately modify the excitability threshold, alter the characteristics of motoneuron discharges, and direction of changes depends on the nature of polarization (anodal vs. cathodal); (2) changes in motoneuron properties in response to trans-spinal polarization last much longer than tsDCS stimulation; (3) long-term polarization will initiate adaptive mechanisms of motoneurons. Adequately, the project provides for three research tasks: (1) Immediate effects of anodal and cathodal trans-spinal polarization during recording from a motoneuron; (2) Prolonged effects of a single session of trans-spinal polarization on motoneuron properties; (3) Influence of long-term, repeated spinal cord polarization on motoneuron properties.

Experiments will be conducted under general anesthesia, in fully controlled conditions (artificial ventilation, monitoring of the body temperature, heart rate, and end-tidal CO_2).

The principal effect of the project will be publications in international scientific journals indexed in the international databases. The results of planned research will introduce new elements to the basic knowledge in the field of electrophysiology of motoneurons and kinesiology. The results of the project will help explain the divergences in the research hypotheses and the results of the studies that have shown insufficient understanding of the physiological mechanisms underlying the polarization processes. The project will also influence potential solutions of practical importance in setting standards for the use of trans-spinal polarization in medicine, sport and rehabilitation.