A substantial part of our lives is spent on the learning of new motor skills: walking, writing, driving, typing, and practicing various types of sport. Motor skill learning refers to the ability to become more skilled at carrying out a sequence of activities by doing this faster and more accurately, and also by the ability to adapt to a change in the external environment. Several authors have argued that motor skills can be acquired by using motor imagery (Mulder, Zijlstra, & Zijlstra, 2004; Allami, Paulignan, Brovelli, & Boussaoud, 2008; Driskell, Copper, & Moran, 1994). Motor imagery has been defined as a cognitive process during which motor actions are internally simulated without producing an overt action. Thus, it can be considered as the mental simulation of a movement (Jeannerod, 2001; Guillot & Collet, 2005). Motor imagery seems to have practical relevance, as it is widely used in rehabilitation programs, as well as in methods that lead to the enhancement of motor skills that have been developed for musicians or athletes (Mulder, 2007; Grèzes & Decety, 2001; Xu, et al., 2014; Gregg & Clark, 2007; Warner & McNeill, 2013). Evidence that motor imagery influences motor skill learning may not only support the acquisition of motor skills in the case of the inability of physical practice or due to disease, but it may also be used, in general, to enhance specific motor skills (Dijkerman, Johnston, & MacWalter, 2004; Luft & Buitrago, 2005).

Current research is especially interested in developing new methods of brain stimulation that may improve motor and cognitive processes. Both TMS (transcranial magnetic stimulation) and tDCS (transcranial direct current stimulation) seem to provide this possibility and these methods indeed received increased interest as a tool for modulating cortical excitability and behavior in a range of clinical settings and experimental conditions. Recently, tDCS was shown to improving motor learning (Cuypers, et al., 2013). Recently, the application of tDCS has also increased, because it is a stimulation paradigm that holds particular promise, as it is noninvasive, painless, well-tolerated and reversive (Stagg & Nitsche, 2011; Antal, Polania, Schmidt-Samoa, Dechent, & Paulus, 2011).

The possibility that tDCS affects motor skill learning induced by motor imagery seems relevant for different disciplines associated with motor functions: neuroreahabilitation, physiotherapy, sport psychology, and specific training programs for athletes and musicians. The proposed project will give important information about the effectiveness of a combination of these methods and will allow to establish differences in brain activity during motor skill learning after tDCS.

In the proposed project, first we would like to establish to what extent tDCS affects learning effects acquired by motor imagery and motor execution after anodal/cathodal and sham stimulation. Participants will be executing, imaging or inhibiting sequential motor sequence, which will be first presented on the computer screen. Learning effects will show to what extent tDCS affects acquiring motor skill by each condition. In the second experiment we will focus on differences in brain activity during motor skill learning after tDCS. Use of the electroencephalogram (EEG) enables to compare brain activity during motor skill learning employing motor imagery/motor execution/motor inhibition after tDCS The last experiment will be focused on a few days' motor training with and without tDCS. Learning effects will provide information whether motor training with tDCS is more effective than motor training without stimulation. The type of stimulation in this experiment (cathodal or anodal) will be chosen depending on the results from the first and the second experiment. Based on previous results of Stagg and Nitsche (2011), we hypothesized that multiple motor training with stimulation will provide better learning effects as compared to motor training without stimulation. The outcome of the project will provide relevant information about how to use these methods in the case of inability of physical practice.

In conclusion, previous studies have shown that noninvasive electrical brain stimulation applied transcranially to the motor cortex (M1) improves motor skill learning both in healthy individuals and in chronic stroke patients. In the proposed project, we will examine whether the combined approach of motor imagery and brain stimulation with tDCS further improves sequential motor skill learning.